

Project Manual

Vol. 1



Prepared for:

Upper Darby School District

8201 Lansdowne Avenue
Upper Darby, PA 19082

Project:

Upper Darby High School Auditorium Improvements

Upper Darby High School

601 N Lansdowne Ave, Drexel Hill, PA 19026

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Conformed Set Documents:

08 November 2023

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None

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section Includes:

1. Remove, except as specifically excluded by provisions of the section:
 - a. Existing work obstructing new work.
 - b. Existing work designated to be removed.
2. Remove from the project site and dispose of materials and equipment removed as selective demolition work, except materials and equipment to be incorporated into new work.
3. Mechanical and Electrical Systems: removal of certain existing mechanical and electrical work is included as work of this Section. The term "Electrical" includes wire systems.
4. Multiple Prime Contracts: carefully coordinate work of this Section with contractors for mechanical and electrical work where mechanical and electrical systems are encountered during selective demolition.
 - a. Contract Documents and Specifications for mechanical and electrical work by other contractors in areas of selective demolition apply to work of this Section.

- B. Related Documents and Sections:

1. General Conditions, Supplementary Conditions, and Division 1 - General Requirements sections apply to work of this Section.
2. Division 1, Section "Cutting and Patching"
3. Division 1, Section "Construction Waste Management"
4. Divisions 22 and 23, Plumbing and HVAC
5. Division 26, Electrical.

1.3 SUBMITTALS

- A. Details: proposed modifications to removal work as required by the Contract Documents. Delete paragraph below if no preinstallation conference.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Supervision: perform selective demolition under the direct supervision of a qualified construction superintendent, experienced in the type of construction involved.
2. Skills: where selective demolition terminates at existing work to remain, perform work using craftsmen skilled in materials and systems involved.
3. Comply with the requirements of Dig Safely – New York in locating existing on-site underground utilities before commencing the demolition work.

1.5 PROJECT CONDITIONS

A. Coordination: coordinate this work with the work of other Sections to avoid any delay or interference with other work.

B. Condition of Structures and Existing Features: by submitting this bid, the Contractor represents that he has fully examined the conditions of the structures and existing features to be demolished. The Owner assumes no responsibility for actual condition of items to be selectively demolished.

1. Conditions existing at time of inspection for bidding will be maintained by Owner insofar as practicable. However, variations within structure may occur by Owner's removal and salvage operations prior to start of selective demolition work. No claims for additional cost due to such variations shall be considered.
2. The Contractor shall continually assess the structural adequacy as demolition proceeds and conditions are uncovered. If previously unseen or unknown structural elements are encountered, promptly advise the Architect for instructions before proceeding further.

C. Protection:

1. Provide protective measures as required to provide free and safe passage of persons to and from occupied portions of the site, and around areas of demolition.
 - a. Ensure that adequate fencing, illumination, exit signs and warning signs are in place whenever such passage is required.
 - b. Install 6-foot-high chain link fence around all work areas to control access to the work areas by unauthorized personnel.
2. Provide necessary shoring, bracing and support to prevent movement, settlement or collapse of element to be demolished, and adjacent facilities to remain.
3. Protect existing finish work to remain in place that becomes exposed during demolition operations from damage.

D. Traffic: conduct demolition operations and debris removal in a manner to ensure minimum interference with roads, driveways, walks and other adjacent occupied or used facilities. Comply with requirements of authorities having jurisdiction.

1. Do not close or obstruct roads, driveways or other 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.
 2. Maintain full access at all times to occupied portions of the site and existing building for fire and emergency equipment.
- E. Utility Services: maintain existing utilities to remain, keep in service, and protect against damage during demolition operations. Do not interrupt existing utilities serving occupied or in use facilities, except when authorized in writing by the Owner authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to governing authorities.
1. If utility systems including mechanical or electrical systems are encountered that are not to remain but give evidence of being in use, promptly advise the Architect for instructions before proceeding.
 2. Contact appropriate utility company owners to coordinate shut off of those utilities required to be removed or to be demolished to accommodate new work.
- F. Advise the Owner, in writing, of encounter with materials suspected to be of a hazardous nature. These materials are not to be handled or removed under this Contract.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas in which work is to be performed. Report to the Architect all prevailing conditions that will adversely affect satisfactory execution of work. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Starting work constitutes acceptance of the existing conditions and Contractor shall then, at his expense, be responsible for correcting all unsatisfactory and defective work encountered.

3.2 PREPARATION

- A. Prior to commencement of work the Contractor and Owner's representative shall inspect respective demolition areas and: Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."

1. Tabulate and, if appropriate, photograph existing conditions which could be misconstrued as damage resulting from selective demolition work;
2. File record photographs with Owner's representative prior to starting work; and,
3. Confirm that items to be removed by the Owner have been removed..

3.3 DEMOLITION

- A. General: perform work using methods which comply with governing regulations and which produce proper surfaces to receive new work.
- B. Concrete and Masonry: demolish in small sections. Cut at junctures with construction to remain using power-driven saws or hand tools; do not use power-driven impact tools.
- C. Locate equipment and promptly remove debris to avoid imposing excessive loads on structure.
- D. Exterior Demolition Work: make necessary provisions to ensure continuous watertight integrity of work to remain.
- E. Cutting torches shall not be used. Cut metals only with saws and abrasive wheels.
- F. Explosives: use of explosives is not permitted.

3.4 DUST CONTROL

- A. Comply with governing regulations pertaining to prevention of raising excessive dust and dirt.
- B. Use water sprinkling, temporary enclosures and other suitable methods to minimize amounts of dust and dirt rising and scattering in the air.
 1. Do not use water sprinkling when it may create hazardous or objectionable conditions such as ice, flooding, polluted runoff or damage.

3.5 SALVAGE MATERIALS

- A. Carefully remove salvage items, clean and protect until disposition.
 1. Items to be incorporated into new work: store and protect until required for installation or for required modification or restoration.
 2. Other salvage items: furnish to Owner and obtain receipt.
- B. Historic artifacts, including cornerstones and their contents, commemorative plaques and tablets, antiques and other articles of historic significance remain the property of the Owner. Notify Owner's Representative if such items are encountered and obtain acceptance regarding method of removal and salvage for Owner.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove debris, rubbish and other materials resulting from demolition operations from project site. Transport and legally dispose of materials off site.
- B. On site burning of removed materials is not permitted.
- C. Storage or sale of removed materials shall not be permitted on the site, except storage of materials to be reused or furnished to Owner.

3.7 CLEAN UP AND REPAIR

- A. Upon completion of demolition work remove tools, equipment and demolished materials from site. Remove protections and leave work areas broom clean.
- B. Return surfaces to remain to condition existing prior to start of demolition work. Repair adjacent construction and surfaces soiled or damaged by excessive demolition work.

END OF SECTION 024113

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SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

- A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mix design, placement procedures and finishes.
 - 1. On-deck concrete slabs.
 - 2. On-grade concrete slabs.

1.3 STANDARDS OF PRACTICE

- A. Detailed recommendations for acceptable practices, while not necessarily a part of these specifications, are available in the following standards and recommendations of the American Concrete Institute (ACI):
 - 1. ACI 117 – Specifications for Tolerances for Concrete Construction and Materials
 - 2. ACI 214 – Guide to Evaluation of Strength Test Results of Concrete.
 - 3. ACI 301 – Specifications for Structural Concrete.
 - 4. ACI 315 – Guide to Presenting Reinforcing Steel Design Details.
 - 5. ACI 318 – Building Code Requirements for Structural Concrete.
 - 6. ACI 347 – Guide to Formwork for Concrete.
 - 7. ACI 309 – Guide for Consolidation of Concrete.
 - 8. ACI 211 – Proportioning Concrete Mixtures.
 - 9. ACI 304 – Guide for Measuring, Mixing, Transporting and Placing Concrete.
- B. Concrete Reinforcing Steel Institute (CRSI)
- C. All standards and recommendations shall be the latest revisions of same at time of bidding, and as listed in the corresponding IBC Referenced Standards.

1.4 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one (1) or more of blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag and silica fume.

1.5 SUBMITTALS

- A. Product Data: For each type of manufactured material and product indicated.
- B. Design Mixtures: For each concrete mixture. Include alternate mix designs when characteristics of materials, project conditions, weather, test results or other circumstances warrant adjustments.
- C. Steel Reinforcement Shop Drawings: Details of fabrication, bending, and placement, prepared according to *ACI 315 – Guide to Presenting Reinforcing Steel Design Details*. Include material, grade, bar schedules, stirrup spacing, bent bar diagrams, arrangement and supports of concrete reinforcement.
- D. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:
 - 1. Coarse Aggregate
 - 2. Fine Aggregate
- E. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements:
 - 1. Cementitious materials.
 - 2. Steel reinforcement and reinforcement accessories.
 - 3. Admixtures.
 - 4. Curing materials.
 - 5. Floor and slab treatments.
 - 6. Bonding agents.
- F. Field quality control test and inspection reports.

1.6 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 complying with ASTM C 94 requirements for production facilities and equipment.
- C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
 2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
- D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.

1.7 DELIVERY, STORAGE AND HANDLING

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

2.3 REINFORCEMENT ACCESSORIES

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

2.4 CONCRETE MATERIALS

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

- B. Fly Ash: ASTM C618, Class C or F.
- C. Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 100 or 120.
- D. Normal-Weight Aggregates: ASTM C 33, coarse aggregate or better, graded. Provide aggregates from a single source.
 - 1. Use largest practical aggregate size for each mix specification.
 - 2. Coarse and fine aggregate shall be free of materials with deleterious reactivity to alkali in cement.
- E. Water: Clean and potable.

2.5 ADMIXTURES

- A. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 - 1. Air-Entraining Admixture: ASTM C260.
 - 2. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - 3. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 4. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 5. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - 6. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 - 7. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.6 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
 - 1. Available Products:
 - a. The Euclid Chemical Company; Eucobar.
 - b. L&M Construction Chemicals, Inc.; E-Con.
 - c. Meadows, W. R., Inc.; Sealtight Evapre.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film, white burlap-polyethylene sheet, or natural cellulose fabric.
- D. Water: Clean and potable.

- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
 - 1. Available Products:
 - a. The Euclid Chemical Company; Kurez DR VOX.
 - b. L&M Construction Chemicals, Inc.; L&M Cure R.
 - c. Meadows, W. R., Inc.; 1100 Clear.

2.7 RELATED MATERIALS

- A. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
- B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

2.8 CONCRETE MIXTURES - GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
- B. Cementitious Materials: Use fly ash, pozzolan, and ground granulated blast-furnace slag as needed to reduce the total amount of Portland cement, which would otherwise be used. Limit percentage, by weight, of cement-replacement materials to a combined total of no more than 20-percent.
- C. Admixtures: Use admixtures according to manufacturer's written instructions, and as required for concrete placement and workability.

2.9 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Provide normal weight concrete.
- B. On-Deck and On-Grade Interior Slabs: Proportion normal-weight concrete mixture as follows:
 - 1. Minimum Compressive Strength: 3,000 psi at 28 days.
 - 2. Maximum Cementitious Materials Content: 540 lb/cu. yd.; use Portland Cement only; cementitious replacement materials (Fly Ash, GGBFS, etc) are not permitted.
 - 3. Slump Limit: 4 inches, plus or minus 1 inch (without superplasticizer).
 - 4. Air Content: Limit to entrapped air. Do not use air-entraining admixtures.
 - 5. Coarse/Fine Aggregate Ratio: Quantity of coarse aggregate (by weight) shall be in the range of 1.2- to 1.4-times the quantity of fine aggregate (by weight).

2.10 FABRICATING REINFORCEMENT

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

2.11 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix and deliver concrete according to ASTM C 94 and furnish batch ticket information.
- B. Ready-Mixed Concrete: Measure, batch, mix and deliver concrete according to ASTM C 94 and ASTM C 1116, and furnish batch ticket information.
 - 1. When air temperature is between 85°F and 90°F (30°C and 32°C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90°F (32°C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static and dynamic loads, and construction loads that might be applied, until concrete structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation and position indicated, within tolerance limits of ACI 117.
- C. Construct forms tight enough to prevent loss of concrete mortar.
- D. Set edge forms, bulkheads and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- E. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt and other debris just before placing concrete.

3.2 EMBEDDED ITEMS

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

3.3 STEEL REINFORCEMENT

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

- B. Clean reinforcement of loose rust and mill scale, earth, ice and other foreign materials.
- C. Accurately position, support and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not weld crossing reinforcing bars.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

3.4 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement and embedded items is complete and that required inspections have been performed.
- B. Batch ticket for concrete shall clearly indicate mix design numbers which correlates with approved mix design.
- C. Do not add water to concrete during delivery, at Project site or during placement, unless approved by concrete plant supplier.
- D. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation.
- E. Deposit concrete in forms in horizontal layers no deeper than 24" (600 mm) and in a manner to avoid inclined construction joints. Place each layer while preceding layer is still plastic, to avoid cold joints.
 - 1. Consolidate placed concrete with mechanical vibrating equipment.
 - 2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the vibrator.
 - 3. Place vibrators to rapidly penetrate placed layer and at least 6" (150 mm) into preceding layer. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix constituents to segregate.

3.5 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defective areas repaired and patched. Remove fins and other projections exceeding ACI 347R limits for class of surface specified.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and

patch tie holes and defective areas. Remove fins and other projections exceeding 1/8" (3 mm) in height.

1. Apply to concrete surfaces exposed to public view or to be covered with a coating or covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster or painting.
- C. Rubbed Finish: Apply the following to smooth-formed finished concrete:
1. Smooth-Rubbed Finish: Not later than 1 day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
 2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix 1 part Portland cement to 1-1/2 parts fine sand with a 1:1 mixture of bonding admixture and water. Add white Portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.6 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with recommendations in ACI 305R for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, bull-floating and/or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces by one or a combination of the following methods:
1. Moisture Curing: Keep surfaces continuously moist for not less than 7 days.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12" (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than 7 days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.7 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Professional. Remove and replace concrete that cannot be repaired and patched to Professional's approval.
- B. Materials: Provide patching materials corresponding to the type of patch required. Submit patching and repair product information for review and approval prior to application.

3.8 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Inspections:
 1. Steel reinforcement placement.
 2. Verification of use of required design mixture(s).
 3. Concrete placement, including conveying and depositing.
 4. Curing procedures and maintenance of curing temperature.
- C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
 1. Testing Frequency: Obtain at least one composite sample for each 50 cubic yards or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.

3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each composite sample.
5. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
6. Compression Test Specimens: ASTM C 31/C 31M.
 - a. Cast and laboratory-cure two sets of two standard cylinder specimens for each composite sample.
 - b. Contractor, at their discretion, may cast and field-cure cylinder specimens for their use.
7. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
 - a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
 - b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).
9. Test results shall be reported in writing to Design Professional, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
10. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.
11. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
12. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

END OF SECTION 033000

SECTION 042000 - UNIT MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Concrete masonry units.
 - 2. Mortar and grout.
 - 3. Steel reinforcing bars.
 - 4. Masonry joint reinforcement.
 - 5. Ties and anchors.
 - 6. Embedded flashing.
 - 7. Miscellaneous masonry accessories.

1.3 DEFINITIONS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For the following:
 - 1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
 - 2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement."
 - 3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
- C. Samples for Initial Selection:
 - 1. Weep holes/vents.

1.5 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For each type and size of the following:
 - 1. Masonry units.
 - 2. Cementitious materials. Include brand, type, and name of manufacturer.

3. Grout mixes. Include description of type and proportions of ingredients.
 4. Reinforcing bars.
 5. Joint reinforcement.
 6. Anchors, ties, and metal accessories.
- B. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
- C. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.6 QUALITY ASSURANCE

- 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.
- C. Masonry Standard: Comply with TMS 602 unless modified by requirements in the Contract Documents.
- D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination."

1.7 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 designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and 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.

1.8 PROJECT CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

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

PART 2 - PRODUCTS

2.1 MASONRY UNITS, 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 in the standard. Do not use units where such defects will be exposed in the completed Work.
- B. Fire-Resistance Ratings: Where indicated, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing according to ASTM E 119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

2.2 CONCRETE MASONRY UNITS

- A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
 2. Provide bullnose units for outside corners unless otherwise indicated.
- B. CMUs: ASTM C 90.
1. Density Classification: Normal weight.
 - 1) Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions of 4, 6, 8, 12, 14, and 16 inches.

2.3 CONCRETE AND MASONRY LINTELS

- A. General: Provide one of the following:
1. Precast Concrete Lintels: ASTM C 1623, matching CMUs in color, texture, and density classification; and with reinforcing bars indicated.
 2. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.4 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
- 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: Not permitted.
- E. 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 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.
 5. Color as selected for Decorative CMU.
- F. Aggregate for Grout: ASTM C 404.
- G. Admixtures: Not permitted.
- H. Water: Potable.

2.5 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.
- B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.
 - 1. Interior Walls: Hot-dip galvanized, carbon steel.
 - 2. Exterior Walls: Hot-dip galvanized, carbon steel.
 - 3. Wire Size for Side Rods: 0.148-inch diameter.
 - 4. Wire Size for Cross Rods: 0.148-inch diameter.
 - 5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
 - 6. Provide in lengths of not less than 10 feet.
- C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

2.6 TIES AND ANCHORS

- A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.
 - 1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 153/A 153M, Class B-2 coating.
 - 2. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
 - 1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- diameter, hot-dip galvanized steel wire.
 - 2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from hot-dip galvanized steel wire.
- C. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
 - 1. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.060-inch- thick, steel sheet, galvanized after fabrication.
 - a. 0.064-inch thick, galvanized sheet may be used at interior walls unless otherwise indicated.
 - 2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from 0.25-inch diameter, hot-dip galvanized steel wire. Mill-galvanized wire may be used at interior walls unless otherwise indicated.

2.7 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing:

1. Provide 26 gage stainless steel flashing. When thru-wall flashing at roof rising wall is exposed to building occupants from building windows or at grade, it shall be Follonbee's TCS II.
2. Copings: Provide Cheney Dovetail design flashing with 3/8 inches long, 45 degree toe drips along each side.
3. Rising Wall and Parapet: Provide Keystone combination receiver and insert flashing receiver shall extend full width of masonry wall and have an up-turned seam at inside.
4. Thru-Wall at Grade: Cheney 3-way Sawtooth design or Keystone 3-way Bond Interlocking Thru-Wall flashing. Top flange shall extend through masonry back-up wall and have an up-turned seam inside. Bottom edge shall project through mortar face 3/16 inch. Round the corners of the bottom edge at outside building corners. Turn down the bottom edge of flashing to be flush with the face of veneer below to prevent sharp edges at building corners.
5. Flexible flashing shall be installed at all relief angles and masonry cavity wall openings.

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, urethane or PVC.
- B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
- C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
- D. Weep/Vent Products:
 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.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Advanced Building Products Inc.; Mortar Maze weep vent.
 - 2) Blok-Lok Limited; Cell-Vent.
 - 3) Heckmann Building Products Inc.; No. 85 Cell Vent.
 - 4) Hohmann & Barnard, Inc.; Quadro-Vent.
 - 5) Wire-Bond; Cell Vent.

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.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Diedrich Technologies, Inc.
 - b. EaCo Chem, Inc.
 - c. ProSoCo, Inc.

2.10 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
 1. Do not use calcium chloride in mortar or grout.
 2. Use portland cement-lime mortar unless otherwise indicated.
- B. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated.
 1. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls, interior load-bearing walls, and for other applications where another type is not indicated, use Type S.
 2. For exterior veneers and interior non-load-bearing partitions use Type N.
 3. Admixtures in mortar are not permitted.
- C. Grout for Unit Masonry: Comply with ASTM C 476.
 1. Use either fine or coarse grout that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
 2. Proportion grout in accordance with ASTM C 476, Proportion Specification.
 3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.
 4. Admixtures in grout are not permitted.

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 work.
 2. Verify that foundations are within tolerances specified.
 3. Verify that reinforcing dowels are properly placed.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.
- B. Build chases and recesses to accommodate items specified in this and other Sections.
- C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.
- D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.

3.3 TOLERANCES

- A. Dimensions and Locations of Elements:
 - 1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch or minus 1/4 inch.
 - 2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch.
 - 3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.
- B. Lines and Levels:
 - 1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
 - 2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
 - 3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
 - 4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
 - 5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
 - 6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
 - 7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.
- C. Joints:

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

3.4 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in bond pattern to match existing; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4-inches Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- F. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.
- G. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.
- H. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.
 1. Install compressible filler in joint between top of partition and underside of structure above.
 2. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078446 "Fire-Resistive Joint Systems."

3.5 MORTAR BEDDING AND JOINTING

- A. Lay CMUs as follows:
 - 1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
 - 2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
 - 3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
 - 4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
- B. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
- C. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.6 MASONRY JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
 - 1. Space reinforcement not more than 16 inches o.c.
 - 2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
 - 3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings.
- B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.
- E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.7 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

- A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:
 - 1. Provide an open space not less than 1 inch wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
 - 2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
 - 3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

3.8 CONTROL AND EXPANSION JOINTS

- A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form control joints in concrete masonry using one of the following methods:
 - 1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.
 - 2. Install preformed control-joint gaskets designed to fit standard sash block.
 - 3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.
 - 4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.
- C. Form expansion joints in brick 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 1/2 inch for installation of sealant and backer rod specified in Section 079200 "Joint Sealants."
- D. Provide horizontal, pressure-relieving joints by either leaving an air space 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.

3.9 LINTELS

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

3.10 FLASHING, WEEP HOLES, AND VENTS

- A. General: Install embedded flashing in masonry at 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. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 8 inches, and through inner wythe to within 1/2 inch of the interior face of wall in exposed masonry. Where interior face of wall is to receive furring or framing, carry flashing completely through inner wythe and turn flashing up approximately 2 inches on interior face.
 3. At stud back-up walls, extend flashing from exterior face of veneer, through veneer, across air space behind veneer, and up face of sheathing at least 8 inches; with upper edge tucked under building paper or building wrap, lapping at least 8 inches.
 4. At lintels and shelf angles, extend flashing a minimum of 4 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 4 inches to form end dams.
 5. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 4 inches or as recommended by flashing manufacturer, and seal lap with two beads of elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated. Provide factory soldered corners with 18-inches minimum legs.
 - a. Extend sheet metal flashing 1/2 inch beyond face of masonry at exterior and turn flashing down to form a drip.
 - b. Solder corners and level changes to be watertight.
- 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 head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:
1. Use specified weep/vent products to form weep holes.
 2. Space weep holes 32 inches o.c. unless otherwise indicated.
- E. Place cavity drainage material immediately above flashing in cavities.

3.11 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.

2. Limit height of vertical grout pours to not more than 60 inches.

3.12 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 concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

END OF SECTION 042000

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SECTION 053100 - STEEL DECK

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 WORK INCLUDED

- A. This Section includes the following:
 - 1. Composite Floor Deck.
- B. Related Sections include the following:
 - 1. Division 01 Section "Quality Assurance Testing and Inspection Services."
 - 2. Division 03 Section "Cast-in-Place Concrete" for concrete fill and reinforcing steel.
 - 3. Division 05 Section "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.

1.3 SUBMITTALS

- A. Product Data: For each type of deck, accessory and product indicated.
- B. Shop Drawings: Show layout and types of deck panels, anchorage details, reinforcing channels, pans, deck openings, special jointing, accessories and attachments to other construction. The use of Contract Drawings for use as Shop Drawings shall not be permitted.
- C. Welding Certificates: Copies of certificates for welding procedures and personnel.
- D. Product Test Reports: From a qualified testing agency indicating that each of the following complies with requirements, based on comprehensive testing of current products:
 - 1. Mechanical fasteners.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed steel deck similar in material, design and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel" and AWS D1.3, "Structural Welding Code--Sheet Steel."
- C. AISI Specifications: Calculate structural characteristics of steel deck according to AISI's "Specification for the Design of Cold-Formed Steel Structural Members."
- D. Comply with applicable articles of Division 01 Section "Quality Assurance Testing and Inspection Services."

1.5 DELIVERY, STORAGE AND HANDLING

- A. Protect steel deck from corrosion, deformation and other damage during delivery, storage and handling.
- B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Canam Steel Corporation; Canam Group, Inc.
 - 2. New Millenium Building Systems, LLC
 - 3. Epic Metals Corporation
 - 4. Nucor Corporation, Vulcraft Division
 - 5. Roof Deck, Inc.

2.2 COMPOSITE STEEL FLOOR DECK

- A. Composite Steel Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 29, the minimum section properties indicated and the following:

1. Galvanized Steel Sheet: ASTM A 653, Structural Steel, Grade 40, G60 zinc coating.
2. Deck Profile: As indicated on Drawings
3. Design Uncoated-Steel Thickness: As indicated on Drawings.
4. Span Condition: Two-span continuous (minimum); unless indicated otherwise on Drawings.

2.3 ACCESSORIES

- A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
- C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 (4.8 mm) minimum diameter.
- D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
- E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), not less than 0.0359" (0.91-mm) design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
- F. Steel Sheet Accessories: Steel sheet, of same material, finish and thickness as deck, unless otherwise indicated.
- G. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), of same material and finish as deck, and of thickness and profile.
- H. Column Closures, End Closures, Z-Closures and Cover Plates: Steel sheet, of same material, finish and thickness as deck, unless otherwise indicated.
- I. Exposed end closures: 1/8" steel with hairline joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

3.2 INSTALLATION, GENERAL

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 29, manufacturer's written instructions and requirements in this Section.
- B. Locate decking bundles to prevent overloading of supporting members.
- C. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
- D. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- E. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to decking.
- F. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of decking and support of other work.
- G. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds and methods used for correcting welding work.

3.3 FLOOR DECK INSTALLATION

- A. Mechanically fasten deck to grouted concrete masonry unit supports.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or 18" (450 mm) and as follows:
 - 1. Mechanically fasten with self-drilling No. 10 (4.8-mm-) diameter or larger carbon-steel screws.

3.4 FIELD QUALITY CONTROL

- A. Field welds will be subject to inspection by Quality Assurance Testing Agency.
- B. Testing agency will report test results promptly and in writing to Contractor and Professional.
- C. Remove and replace work that does not comply with specified requirements.

- D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.5 REPAIRS AND PROTECTION

- A. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION 053100

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SECTION 055213 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Steel pipe and tube railings.
 - 2. Stainless steel handrails.
 - 3. Stainless steel cable infill at guard rail railings.

1.3 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- C. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Manufacturer's product lines of mechanically connected railings.
 - 2. Railing brackets.
 - 3. Grout, anchoring cement, and paint products.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

- C. Samples for Initial Selection: For products involving selection of color, texture, or design.
- D. 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.
 - 2. Fittings and brackets.
- E. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- F. Qualification Data: For testing agency.
- G. Welding certificates.
- H. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.
- I. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect mechanical finishes on exposed surfaces 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 metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design railings, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
 - 1. Steel: 72 percent of minimum yield strength.
- C. Structural Performance: Railings shall 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. Stainless Steel cable railing Infill of Guards:
 - a. Each cable tensioned to 200-250 lbs.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

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.

2.3 STEEL AND IRON

- A. Pipe: ASTM A 53/A 53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.
 - 1. Provide galvanized finish for exterior installations and where indicated.
- B. Plates, Shapes, and Bars: ASTM A 36/A 36M.
- C. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

2.4 STAINLESS STEEL

- A. Pipe: ASTM A 312/A 312M, Grade TP 304.
- B. Castings: ASTM A 743/A 743M, Grade CF 8 or CF 20.

2.5 FASTENERS

- A. General: Provide the following:
 - 1. Ungalvanized-Steel Railings: Plated steel fasteners complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5 for zinc coating.
 - 2. Hot-Dip Galvanized Railings: Type 304 stainless-steel or hot-dip zinc-coated steel fasteners complying with ASTM A 153/A 153M or ASTM F 2329 for zinc coating.
 - 3. Stainless-Steel Railings: Type 304 stainless-steel fasteners.
- B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.
- C. Fasteners for Interconnecting Railing Components:
 - 1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.
 - 2. Provide Phillips, tamper-resistant, or square or hex socket flat-head machine screws for exposed fasteners unless otherwise indicated.
- D. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
 - 1. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated
 - 2. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

2.6 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

1. For stainless-steel railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
- B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- C. Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- D. Intermediate Coats and Topcoats: Refer to Division 09 painting Sections.
- E. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- F. 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.

2.7 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
- B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- 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 surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
- I. Form changes in direction as follows:
 - 1. By radius bends of radius indicated. Mitered corners are not acceptable.
- J. 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.
- K. Close exposed ends of railing members with prefabricated end fittings.
- L. 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.
- M. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
- N. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.
- O. For railing posts set in concrete, provide stainless-steel 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.

2.8 STEEL AND IRON FINISHES

- A. Galvanized Railings:
 - 1. Hot-dip galvanize exterior steel railings, including hardware, after fabrication.
 - 2. Comply with ASTM A 123/A 123M for hot-dip galvanized railings.
 - 3. Comply with ASTM A 153/A 153M for hot-dip galvanized hardware.
 - 4. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

- B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
- C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.
- D. For nongalvanized-steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves; however, galvanize anchors to be embedded in exterior concrete or masonry
- E. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.
 - 1. Shop prime uncoated railings with universal shop primer unless zinc-rich primer is indicated.

2.9 STAINLESS-STEEL FINISHES

- A. Remove tool and die marks and stretch lines, or blend into finish.
- B. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
 - 1. Directional Satin Finish: No. 4.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION, GENERAL

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

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

3.3 RAILING CONNECTIONS

- A. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.
- B. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches of post.

3.4 ANCHORING POSTS

- A. Anchor posts to metal surfaces. Shop and field weld unless noted otherwise. Provide bolt/flange at non-metallic surfaces only.
- B. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
1. For stainless-steel pipe railings, weld flanges to post and bolt to supporting surfaces.
 2. For steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.

3.5 ATTACHING RAILINGS

- A. Anchor railing ends as indicated on Drawings.
- B. Attach railings to wall with wall brackets, except where end flanges are used. Provide brackets with 1-1/2-inch clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
1. Use type of bracket indicated.
 2. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

- C. Secure wall brackets and railing end flanges 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.
- D. Refer to Section 099000 "Painting" for finish painting of railings.

3.6 ADJUSTING AND CLEANING

- A. Clean stainless steel by washing thoroughly with clean water and soap and rinsing with clean water.
- B. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-prime and field paint surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

3.7 PROTECTION

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

END OF SECTION 055213

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SECTION 057313 - GLAZED DECORATIVE METAL RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Glazed guardrails with glass infill.

1.3 DEFINITIONS

- A. Railings: Guards, handrails, and similar devices used for protection of occupants at open-sided floor areas and for pedestrian guidance and support, visual separation, or wall protection.

1.4 COORDINATION AND SCHEDULING

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible.
- 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 items to Project site in time for installation.

1.5 PREINSTALLATION MEETINGS

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

1.6 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Manufacturer's product lines of railings assembled from standard components.
 - 2. Grout, anchoring cement, and paint products.

- B. Shop Drawings: Include plans, elevations, sections, and attachment details.
 - 1. For illuminated railings, include wiring diagrams and roughing-in details.
- C. Samples for Initial Selection: For products involving selection of color, texture, or design.
- D. 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.
 - 2. Each type of glass required.
 - 3. Fittings and brackets.
 - 4. Assembled Samples of railing systems, made from full-size components, including top rail, post, handrail, and infill. Show method of finishing members at intersections. Samples need not be full height.
- E. Design Calculations Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer certified installer.

1.8 QUALITY ASSURANCE

- A. Installer Requirements: Installed by manufacturer or manufacturer certified installer.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
 - 3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."
- C. 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 as a cut-down version.
 - 2. Build mockups for each form and finish of railing consisting of two posts, top rail, infill area, and anchorage system components that are full height and are not less than 24 inches in length.

1.9 FIELD CONDITIONS

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of railing from single source from single manufacturer.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide VIVA Railings, LLC; SHOE or comparable product by one of the following:
 - 1. Blum, Julius & Co., Inc.
 - 2. CraneVeyor Corp.
 - 3. Morse Industries.
 - 4. Tri Tech, Inc.
 - 5. Wylie Systems.
- C. Product Options: Drawings indicate size, profiles, and dimensional requirements of railings and are based on the specific system indicated.
 - 1. If modifications are proposed, submit data to Architect for review.
 - 2. Post: No Post, Aluminum Base Shoe.
 - 3. Top Rail: U-Cap cross section shape.
 - 4. Infill Panel: Laminated Tempered glass.

2.2 PERFORMANCE REQUIREMENTS

- A. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
 - 1. Aluminum: The lesser of minimum yield strength divided by 1.65 or minimum ultimate tensile strength divided by 1.95.
 - 2. Stainless Steel: 60 percent of minimum yield strength.
 - 3. Glass: 25 percent of mean modulus of rupture (50 percent probability of breakage), as listed in "Mechanical Properties" in AAMA's Aluminum Curtain Wall Series No. 12, "Structural Properties of Glass."
- B. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Handrails and Top Rails of Guards:

- a. Uniform load of 50 lbf/ft. (0.73 kN/m) applied in any direction.
 - b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 2. Infill of Guards:
 - a. Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
 - b. Infill load and other loads need not be assumed to act concurrently.
 3. Glass-Supported Railings: Support each section of top rail by a minimum of three glass panels or by other means so top rail will remain in place if any one panel fails.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior railings by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- 2.3 METALS, GENERAL
- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
 - B. Brackets, Flanges, and Anchors: Same metal and finish as supported rails unless otherwise indicated.
 1. Provide cast-stainless steel wall brackets with flange tapped for concealed anchorage with vertical and horizontal adjustment capability.
- 2.4 STAINLESS STEEL
- A. Tubing: ASTM A 554, Grade MT 316.
 - B. Pipe: ASTM A 312/A 312M, Grade MT 316.
 - C. Castings: ASTM A 743/A 743M, Grade CF 8M or CF 3M.
 - D. Sheet, Strip, Plate, and Flat Bar: ASTM A 666 or ASTM A 240/A 240M, Grade MT 316..
 - E. Bars and Shapes: ASTM A 276, Grade MT 316..

2.5 GLASS AND GLAZING MATERIALS

- A. Safety Glazing: Glazing shall comply with 16 CFR 1201, Category II.
- B. Tempered Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated), Type 1 (transparent flat glass), Quality-Q3. Provide products that have been tested for surface and edge compression according to ASTM C 1048 and for impact strength according to 16 CFR 1201 for Category II materials.
 - 1. Glass Color: Clear.
 - 2. Thickness for Glass Infill Panels: 0.5 inch
 - 3. Thickness: As indicated on Drawings.
- C. Laminated Glass: ASTM C 1172, Condition A (uncoated), Type I (transparent flat glass), Quality-Q3 with two plies of glass and interlayer.
 - 1. Kind: LT (laminated tempered).
 - 2. Glass Color: Clear.
 - 3. Interlayer: SGP; 0.035 inch thick.
 - a. Interlayer Color: Clear.
 - 4. Interlayer: PVB; 0.060 inch (1.52 mm) thick.
 - a. Interlayer Color: Clear.
 - 5. Glass Plies for Glass Infill Panels: Thickness required by structural loads, but not less than 0.24 inch each.
- D. Glazing Cement and Accessories for Structural Glazing: Glazing cement, Setting blocks, shims, and related accessories as recommended or supplied by railing manufacturer for installing structural glazing in metal subrails.
 - 1. Glazing Cement: Nonshrinking organic cement designed for curing by passing an electric current through metal subrail holding glass panel, as standard with manufacturer.
- E. Glazing Gaskets for Glass Infill Panels: Glazing gaskets and related accessories recommended or supplied by railing manufacturer for installing glass infill panels in post-supported railings.

2.6 FASTENERS

- A. Fastener Materials: Unless otherwise indicated, provide the following:
 - 1. Aluminum Components: Type 316 stainless-steel fasteners.
 - 2. Stainless-Steel Components: Type 316 stainless-steel fasteners.
 - 3. Dissimilar Metals: Type 316 stainless-steel fasteners.

- B. Fasteners for Anchoring to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.
- C. Provide concealed fasteners for interconnecting railing components and for attaching railings to other work.
 - 1. Provide hex or hex socket or hex button machine screws for exposed fasteners unless otherwise indicated.

2.7 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
 - 1. For aluminum railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
- B. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.
- C. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. 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: 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.

2.8 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
- B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate. 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 Type 1 welds; no evidence of a welded joint.
- I. Mechanical 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.
- J. 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.
- K. Close exposed ends of hollow railing members with prefabricated end fittings.
- L. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work where 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 to prevent bracket or fitting rotation and crushing of substrate.

2.9 GLAZING PANEL FABRICATION

- A. General: Fabricate to sizes and shapes required; provide for proper edge clearance and bite on glazing panels.
 - 1. Grind smooth exposed edges, including those at open joints, to produce square edges with slight chamfers at junctions of edges and faces.

- B. Infill Panels: Provide laminated, tempered glass panels.

2.10 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.11 STAINLESS-STEEL FINISHES

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

2.12 ALUMINUM FINISHES

- A. Mechanical Finish: AA-M3x; sand top rails, handrails, and intermediate rails in one direction only, parallel to length of railing, with 120- and 320-grit abrasive. After installation, polish railings with No. 0 steel wool immersed in paste wax, then rub to a luster with a soft dry cloth.
- B. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor to examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.
- B. Installation Tolerances: Structural steel and concrete slabs to be within 1/8 inch in 10 ft horizontally and 1/8 inch vertically. Correct conditions out-of-tolerance to meet railing manufacturer's requirements.

3.2 INSTALLATION, GENERAL

- A. Fit exposed connections together to form tight, hairline joints.
- B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
 - 1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 - 2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
 - 3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.
- C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
 - 1. Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- D. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 INSTALLING GLASS PANELS

- A. Glass-Supported Railings: Install assembly to comply with railing manufacturer's written instructions.
 - 1. Attach base channel to building structure, then insert glass into base channel and dry set using a continuous mechanical compression along the run of glass.

- a. Support glass panels in base channel at quarter points with channel-shaped setting blocks that also act as shims to maintain uniform space for glazing cement.
 2. Adjust spacing of glass panels so gaps between panels are equal before securing in position.
 3. Erect glass railings under direct supervision of manufacturer's authorized technical personnel.
- B. Post-Supported Glass Railings: Install assembly to comply with railing manufacturer's written instructions and with requirements in other Part 3 articles. Erect posts and other metal railing components, then set factory-cut glass panels. Do not cut, drill, or alter glass panels in field. Protect edges from damage.

3.4 CLEANING

- A. Clean aluminum and stainless steel by washing thoroughly with water and soap, rinsing with clean water, and wiping dry.
- B. Clean copper alloys according to metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.
- C. Clean and polish glass as recommended in writing by manufacturer. Wash both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion.
- D. Clean wood rails by wiping with a damp cloth and then wiping dry.

3.5 PROTECTION

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

END OF SECTION 057313

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. Section Includes:
 - 1. Wood blocking and nailers.
 - 2. Plywood backing panels.
 - 3. Wood treatment.

1.3 DEFINITIONS

- A. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.
- B. Lumber grading agencies, and the abbreviations used to reference them, include the following:
 - 1. NLGA: National Lumber Grades Authority.
 - 2. SPIB: The Southern Pine Inspection Bureau.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
- B. Fastener Patterns: Full-size templates for fasteners in exposed framing.
- C. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
- D. Evaluation Reports: For the following, from ICC-ES:
 - 1. Wood-preservative-treated wood.
 - 2. Fire-retardant-treated wood.

3. Power-driven fasteners.
4. Powder-actuated fasteners.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.6 DELIVERY, STORAGE, AND HANDLING

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

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS20 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.
- B. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

- A. Preservative Treatment by Pressure Process: AWPAC U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.
 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
 2. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.

- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
 - 1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
- D. Application: Treat items indicated on Drawings, and the following:

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
 - 1. Use treatment that does not promote corrosion of metal fasteners.
 - 2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
 - 3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201 at 92 percent relative humidity. Use where exterior type is not indicated.
 - 4. Design Value Adjustment Factors: Treated lumber shall be tested according ASTM D5664 and design value adjustment factors shall be calculated according to ASTM D6841.
- C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.
- D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
- E. Application: Treat items indicated on Drawings, and the following:
 - 1. Concealed blocking.
 - 2. Plywood backing panels.

2.4 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 - 1. Blocking.
 - 2. Nailers.
 - 3. Rooftop equipment bases and support curbs.
 - 4. Cants.
 - 5. Furring.
 - 6. Grounds.
- B. For items of dimension lumber size, provide Standard, Stud, or No.3 grade lumber of any species.

2.5 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: DOC PS1, Exterior, C-D plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 1/2-inch nominal thickness.

2.6 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners of Type 304 stainless steel.
 - 2. Provide stainless steel type fasteners at all wood preservative treated materials including all roofing and exterior blocking.
- B. Nails, Brads, and Staples: ASTM F1667.
- C. Power-Driven Fasteners: NESNER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Lag Bolts: ASME B18.2.1.
- F. Bolts: Steel bolts complying with ASTM A307, Grade A; with ASTM A563 hex nuts and, where indicated, flat washers.
- G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry assemblies and equal to four times the load imposed when installed in concrete as determined by testing per ASTM E488 conducted by a qualified independent testing and inspecting agency.
 - 1. Material: Carbon-steel components, zinc plated to comply with ASTM B633, Class Fe/Zn5.

2. Material: Stainless steel with bolts and nuts complying with ASTM F593 and ASTM F594, Alloy Group 1 or 2.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry 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 WCD1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.
- D. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
- E. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated.
- F. 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.
- G. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 1. NESNER-272 for power-driven fasteners.
 2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
- H. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 WOOD 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. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

3.3 WOOD FURRING INSTALLATION

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

END OF SECTION 061053

SECTION 061600 - SHEATHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Wall sheathing.
 - 2. Sheathing joint and penetration treatment.

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.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.5 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-Test-Response Characteristics: For assemblies with fire-resistance ratings, provide materials and construction identical to those of assemblies tested for fire

resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory.

2.2 WALL SHEATHING

- A. Glass-Mat Gypsum Wall Sheathing: ASTM C 1177/1177M.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. CertainTeed Corporation; GlasRoc.
 - b. G-P Gypsum Corporation; Dens-Glass Gold.
 - c. National Gypsum Company; Gold Bond e(2)XP.
 - d. United States Gypsum Co.; Securock.
2. Type and Thickness: Refer to Drawings.
3. Size: 48 by 96 inches.

2.3 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
1. For wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
- B. Power-Driven Fasteners: NES NER-272.
- C. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in 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 according to ASTM B 117.
1. For steel framing less than 0.0329 inch thick, use screws that comply with ASTM C 1002.
 2. For steel framing from 0.033 to 0.112 inch thick, use screws that comply with ASTM C 954.

2.4 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

- A. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C 834, 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.

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. NES NER-272 for power-driven fasteners.
 2. Table 2304.9.1, "Fastening Schedule," in ICC's "International Building Code."
- D. Coordinate 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.
- E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
- F. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 GYPSUM SHEATHING INSTALLATION

- A. Comply with GA-253 and with manufacturer's written instructions.
 1. Fasten gypsum sheathing to wood framing with nails or screws.
 2. Install boards with a 3/8-inch gap where non-load-bearing construction abuts structural elements.
 3. Install boards 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

boards without forcing. Abut ends of boards over centers of studs, and stagger end joints of adjacent boards not less than one stud spacing. Attach boards at perimeter and within field of board to each steel stud.

1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of boards.
- D. Vertical Installation: Install board vertical edges centered over studs. Abut ends and edges of each board with those of adjacent boards. Attach boards at perimeter and within field of board 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 boards.
- E. Seal sheathing joints according to sheathing manufacturer's written instructions.
1. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and trowel silicone emulsion 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.

END OF SECTION 061600

SECTION 064219 – PLASTIC-LAMINATE-FACED WOOD PANELING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Plastic-laminate-clad flush paneling.
 - 2. Concealed clip hangers.
 - 3. Metal trim for paneling.
- B. Related Sections include the following:
 - 1. Division 6 Section "Rough Carpentry".
 - 2. Division 9 Section "Gypsum Board".

1.3 DEFINITIONS

- A. Paneling includes wood furring, blocking, and shims for installing paneling, unless concealed within other construction before paneling installation.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated, including finishing materials and processes.
- B. Shop Drawings: Show location of paneling, large-scale details, attachment devices, and other components. Include dimensioned plans and elevations.
- C. Samples for Verification:
 - 1. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) long, representing actual product.
- D. Product Certificates: For each type of product, signed by product manufacturer.
- E. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

- F. Qualification Data: For Installer and fabricator.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance. Shop is a certified participant in AWI's Quality Certification Program.
- B. Installer Qualifications: Certified participant in AWI's Quality Certification Program.
- C. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards" for grades of paneling indicated for construction, finishes, installation, and other requirements.
1. Provide AWI Quality Certification Program labels and certificates indicating that paneling, including installation, complies with requirements of grades specified.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install paneling until building is enclosed, wet work is complete, and HVAC system is operating and will maintain temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Field Measurements: Where paneling is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings.

1.8 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that paneling can be installed as indicated.

PART 2 - PRODUCTS

2.1 PANEL FABRICATORS

- 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. Cal-Dak Cabinets.
 2. CampbellRhea.
 3. R.C. Smith Company.
 4. Sidney Millwork Company.
 5. Stevens Industries, Inc.
 6. Techline USA, LLC.
 7. TMI Systems Design Corporation.
- B. Fabricators: Subject to compliance with requirements, provide paneling by one of the following:

2.2 MATERIALS

- A. General: Provide materials that comply with requirements of AWI's quality standard for quality grade specified, unless otherwise indicated.
- B. Wood Products: Comply with the following:
1. Medium-Density Fiberboard: ANSI A208.2, Grade MD, made with binder containing no urea formaldehyde.
 2. Particleboard: ANSI A208.1, Grade M-2.
 3. Particleboard: Straw-based particleboard complying with requirements in ANSI A208.1, Grade M-2, except for density.
 4. Softwood Plywood: DOC PS 1, Medium Density Overlay.
 5. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1, made with adhesive containing no urea formaldehyde.
- C. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated, or if not indicated, as required by woodwork quality standard.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering high-pressure decorative laminates that may be incorporated into the Work include, but are not limited to, the following:
 2. 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. Panolam Industries Incorporated.
 - g. Wilsonart International; Div. of Premark International, Inc.
- D. Adhesives: Do not use adhesives that contain urea formaldehyde.
- E. Adhesive for Bonding Plastic Laminate: Unpigmented contact cement.
- 1. Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified above for faces.

2.3 CLIP HANGERS

- A. Manufacturer: Basis-Of-Design: Monarch Metal Fabrication; 1625 Sycamore Ave., Bohemia, NY 11716. ASD. Phone: 631-563-8967. Fax: 631-563-8976. Website: www.monarchmetal.com, Email: zclip@monarchmetal.com, or approved equal.
- B. System Description: Two-piece interlocking assembly, similar to a French cleat, designed for removable installation of wall panels and other panels without exposed fasteners. System consists of 2 parts with shorter Z Clips mechanically attached to back of panel and the longer continuous length attached to wall substrate.
- C. Basis-Of-Design: Monarch Z Clip: MF-375: Extruded 6063-T6 aluminum in accordance to ASTM B221; mill finish.
- 1. Stock clip size: 2.0 inches.
 - 2. Stock continuous length: Lengths as indicated on drawings.
 - 3. Lift-off: 3/8 inch.
 - 4. Projection: 1/4 inch.
 - 5. Total Height: 2-3/8 inches with two clip sections fully engaged.
 - 6. Holes: 8 inches on centers.
- D. Fasteners: #8 pan head, deep thread screws.

2.4 PANEL METAL TRIM

- A. Basis-Of-Design: Monarch Easy Panel Wall System (or approved equal).
- 1. Profile: Wide Channel.
 - 2. Reveal Thickness: 1".
 - 3. Panel Thickness: 3/4".
 - 4. Finish: Clear Anodized.
 - 5. Standard Length: 144".
- B. System included Horizontal Reveal (EPS-H075-WC), Vertical Reveal (EPS-V075-WC), Edge Trim (EPS-ET075-N), Outside Corner (EPS-OC075-N), Inside Corner (EPS-IC075-N).

2.5 PLASTIC-LAMINATE-CLAD FLUSH PANELING

- A. Grade: Premium.
- B. Plastic-Laminate Cladding: High-pressure decorative laminate, in the following grades:
 - 1. Faces: Grade VGS.
 - 2. Backs: Grade BKL.
 - 3. Exposed Edges: Same as faces.
- C. Colors, Patterns, and Finishes: Refer to finish schedule on drawings for manufacturers, products, styles and colors:
 - 1. Grain Direction: Vertical.
- D. Panel Core Construction: Particleboard or medium-density fiberboard.
- E. Panel Thickness: 3/4-inch (19-mm) minimum thickness.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

- A. Grade: Install paneling to comply with requirements for same grade specified in Part 2 for fabrication of type of paneling involved.
- B. Install paneling level, plumb, true, and straight with no distortions. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm). Install with no more than 1/16 inch in 96-inch (1.6 mm in 2400-mm) vertical cup or bow and 1/8 inch in 96-inch (3 mm in 2400-mm) horizontal variation from a true plane.
 - 1. For flush paneling with revealed joints, install with variations in reveal width, alignment of top and bottom edges, and flushness between adjacent panels not exceeding 1/16 inch (1.5 mm).
- C. Scribe and cut paneling to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

- D. Anchor paneling to supporting substrate with concealed clip hangers.

3.3 ADJUSTING AND CLEANING

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

END OF SECTION 064219

SECTION 064600 - WOOD TRIM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Interior standing and running trim.
 - 2. Stair Treads and Risers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
- C. Samples:
 - 1. Lumber products with transparent finish, for each finish system and color, with exposed surface finished.

1.4 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
- B. Fire-Test-Response Characteristics: Where fire-retardant materials or products are indicated, provide materials and products with specified fire-test-response characteristics as determined by testing identical products per test method indicated by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify with appropriate markings of applicable testing and inspecting agency in the form of separable paper label or, where required by authorities having jurisdiction, imprint on surfaces of materials that will be concealed from view after installation.

- C. Forest Certification: Provide interior architectural woodwork produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC 1.2, "Principles and Criteria."
- D. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

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

1.6 FIELD CONDITIONS

- A. Environmental Limitations for Interior Work: Do not deliver or install interior wood trim until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.
 - 2. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating woodwork without field measurements. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.7 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that wood trim can be supported and installed as indicated.

PART 2 - PRODUCTS

2.1 WOOD TRIM, GENERAL

- A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of wood trim indicated for construction, finishes, installation, and other requirements.

2.2 WOOD CAPS AT HALF WALLS HS AUDITORIUM

- A. Grade: Premium.
- B. Wood Species: Plain-sawn, Oak.
- C. Stain: Submit Stain To Best Match Existing.

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this Article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified.
 - 1. Do not use treated materials that do not comply with requirements of referenced woodworking standard or that are warped, discolored, or otherwise defective.
 - 2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
 - 3. Identify fire-retardant-treated materials with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection, or another testing and inspecting agency acceptable to authorities having jurisdiction.
- B. Fire-Retardant-Treated Lumber by Pressure Process: Comply with performance requirements of AWPA C20 (lumber) and AWPA C27 (plywood). Use the following treatment type:
 - 1. Interior Type A: Low-hygroscopic formulation.
 - 2. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking plant certified by testing and inspecting agency.
 - 3. Mill lumber before treatment and implement special procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.

4. Kiln-dry materials before and after treatment to levels required for untreated materials.

2.4 FABRICATION

- A. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.
- B. Fabricate wood trim to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:
 1. Edges of Solid-Wood (Lumber) Members: 1/16 inch unless otherwise indicated.
 2. Edges of Rails and Similar Members More Than 3/4 Inch Thick: 1/8 inch.
- C. Backout or groove backs of flat trim members and kerf backs of other wide, flat members except for members with ends exposed in finished work.
- D. Assemble wood trim in shop except where shipping limitations require field assembly.

2.5 FINISHING

- A. Transparent Finish:
 1. Grade: Premium.
 2. Staining: Match Architect's sample.
 3. Sheen: Satin, 31-45 gloss units measured on 60-degree gloss meter per ASTM D 523.
- B. Preparations for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing wood trim, as applicable to each unit of work.
 1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of wood trim. Apply two coats to surfaces installed in contact with concrete or masonry and to end-grain surfaces.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition wood trim to average prevailing humidity conditions in installation areas.

3.2 INSTALLATION

- A. Grade: Install wood trim to comply with same grade as item to be installed.
- B. Install wood trim level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches.
- C. Scribe and cut wood trim to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- D. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible. Do not use pieces less than 60 inches long except where shorter single-length pieces are necessary. Scarf running joints and stagger in adjacent and related members.
 - 1. Install standing and running trim with no more variation from a straight line than 1/8 inch in 96 inches.

3.3 ADJUSTING AND CLEANING

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

END OF SECTION 064600

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SECTION 066510 - SOLID SURFACE FABRICATIONS

PART 1 — GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including general and supplementary conditions and Division 1 Specification Sections, apply to this Section.

1.3 SUMMARY

- A. This Section includes the following horizontal and trim solid surface product types:
 - 1. Countertops where indicated on Drawing Room Finish Schedule.
 - 2. Window stools.
- B. Related Sections include the following:
 - 1. Division 5 Section "Metal Fabrications" for Blocking.
 - 2. Division 6 Section "Rough Carpentry" for Blocking.
 - 3. Division 22 Section "Plumbing Fixtures."

1.4 DEFINITION

- A. Solid surface is defined as nonporous, homogeneous material maintaining the same composition throughout the part with a composition of acrylic polymer, aluminum trihydrate filler and pigment.

1.5 SUBMITTALS

- A. Product data:
 - 1. For each type of product indicated.
 - 2. Product data for the following:
 - a. Solid surface counter tops and accessories.
- B. Shop drawings:
 - 1. Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices and other components.
 - a. Show full-size details, edge details, thermoforming requirements, attachments, etc.
 - b. Show locations and sizes of furring, blocking, including concealed blocking and reinforcement specified in other Sections.
 - c. Show locations and sizes of cutouts and holes for plumbing fixtures, faucets, soap dispensers, waste receptacle and other items installed in solid surface.

C. Samples:

1. For each type of product indicated.
 - a. Submit minimum 6-inch by 6-inch sample in specified gloss.
 - b. Cut sample and seam together for representation of inconspicuous seam.
 - c. Indicate full range of color and pattern variation.

D. Product data:

1. Indicate product description, fabrication information and compliance with specified performance requirements.

E. Product certificates:

1. For each type of product, signed by product manufacturer.

F. Fabricator/installer qualifications:

1. Provide copy of certification number.

G. Manufacturer certificates:

1. Signed by manufacturers certifying that they comply with requirements.

H. Maintenance data:

1. Submit manufacturer's care and maintenance data, including repair and cleaning instructions.
 - a. Maintenance kit for finishes shall be submitted.
2. Include in project closeout documents.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Shop that employs skilled workers who custom fabricate products similar to those required for this project and whose products have a record of successful in-service performance.

B. Fabricator/installer qualifications:

1. Work of this section shall be by a certified fabricator/installer, certified in writing by the manufacturer.

C. Applicable standards:

1. Standards of the following, as referenced herein:
 - a. American National Standards Institute (ANSI)
 - b. American Society for Testing and Materials (ASTM)
 - c. National Electrical Manufacturers Association (NEMA)
 - d. NSF International
2. Fire test response characteristics:

- a. Provide with the following Class A (Class I) surface burning characteristics as determined by testing identical products per UL 723 (ASTM E84) or another testing and inspecting agency acceptable to authorities having jurisdiction:
 - 1) Flame Spread Index: 25 or less.
 - 2) Smoke Developed Index: 450 or less.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver no components to project site until areas are ready for installation.
- B. Store components indoors prior to installation.
- C. Handle materials to prevent damage to finished surfaces.
 - 1. Provide protective coverings to prevent physical damage or staining following installation for duration of project.

1.8 WARRANTY

- A. Provide manufacturer's warranty against defects in materials.
 - 1. Warranty shall provide material and labor to repair or replace defective materials.
 - 2. Damage caused by physical or chemical abuse or damage from excessive heat will not be warranted.
- B. Manufacturer's warranty period:
 - 1. Ten years from date of substantial completion.

1.9 MAINTENANCE

- A. Provide maintenance requirements as specified by the manufacturer.

PART 2 — PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers:
 - 1. Subject to compliance with requirements, provide products by one of the following:
 - a. Corian® surfaces from the DuPont company (basis of design) or approved equal.

2.2 MATERIALS

- A. Solid polymer components

1. Cast, nonporous, filled polymer, not coated, laminated or of composite construction with through body colors meeting ANSI Z124.3 or ANSI Z124.6, having minimum physical and performance properties specified.
2. Superficial damage to a depth of 0.010 inch (.25 mm) shall be repairable by sanding and/or polishing.

B. Thickness: 1/2 inch

C. Edge treatment: One inch (1") thick full bullnose

D. Performance characteristics:

Property	Typical Result	Test
Tensile Strength	6,000 psi	ASTM D 638
Tensile Modulus	1.5×10^{-6} psi	ASTM D 638
Tensile Elongation	0.4% min.	ASTM D 638
Flexural Strength	10,000 psi	ASTM D 790
Flexural Modulus	1.2×10^{-6} psi	ASTM D 790
Hardness	>85	Rockwell "M" Scale ASTM D 785 ASTM D 2583
Thermal Expansion	3.02×10^{-5} in./in./°C (1.80×10^{-5} in./in./°F)	ASTM D 696
Gloss (60° Gardner)	5–75 (matte—highly polished)	ANSI Z124
Light Resistance Method 3.3	(Xenon Arc) No effect	NEMA LD 3-2000
Wear and Cleanability	Passes	ANSI Z124.3 & Z124.6
Stain Resistance: Sheets	Passes	ANSI Z124.3 & Z124.6
Fungus and Bacteria Resistance	Does not support microbial growth	ASTM G21
Boiling Water Resistance	No visible change	NEMA LD 3-2000 Method 3.5
High Temperature Resistance Method 3.6	No change	NEMA LD 3-2000
Izod Impact (Notched Specimen)	0.28 ft.-lbs./in. of notch	ASTM D 256 (Method A)
Ball Impact	No fracture—1/2 lb. ball:	NEMA LD 3-2000
Resistance: Sheets	1/4" slab—36" drop 1/2" slab—144" drop	Method 3.8
Weatherability	$\Delta E^*_{94} < 5$ in 1,000 hrs.	ASTM G 155
Specific Gravity †	1.7	
Water Absorption	Long-term 0.4% (3/4") 0.6% (1/2") 0.8% (1/4")	ASTM D 570
Toxicity	99 (solid colors) 66 (patterned colors)	Pittsburgh Protocol ("LC50" Test)
Flammability	All colors (Class I and Class A)	ASTM E 84, NFPA 255 & UL 723
Flame Spread Index	<25	
Smoke Developed Index	<25	

- † Approximate weight per square foot: 1/4" (6 mm) 2.2 lbs., 1/2" (12.3 mm) 4.4 lbs.
Shapes meet or exceed the ANSI Z124.3 and ANSI Z124.6 standards for plastic sinks and lavatories. NEMA results based on the NEMA LD 3-2000

2.3 ACCESSORIES

- A. Joint adhesive:
 - 1. Manufacturer's standard one- or two-part adhesive kit to create inconspicuous, nonporous joints.
- B. Sealant:
 - 1. Manufacturer's standard mildew-resistant, FDA-compliant, NSF 51-compliant (food zone — any type), UL-listed silicone sealant in colors matching components.
- C. Conductive tape:
 - 1. Manufacturer's standard aluminum foil tape, with required thickness, for use with cutouts near heat sources.
- D. Insulating felt tape:
 - 1. Manufacturer's standard for use with conductive tape in insulating solid surface material from adjacent heat source.
- E. Fasteners and accessories:
 - 1. Stainless steel fasteners

2.4 FACTORY FABRICATION

- A. Shop assembly
 - 1. Fabricate components to greatest extent practical to sizes and shapes indicated, in accordance with approved shop drawings and manufacturer's printed instructions and technical bulletins.
 - 2. Form joints between components using manufacturer's standard joint adhesive without conspicuous joints.
 - a. Reinforce with strip of solid polymer material, 2" wide.
 - 3. Provide factory cutouts for plumbing fittings and bath accessories as indicated on the drawings.
 - 4. Rout and finish component edges with clean, sharp returns.
 - a. Rout cutouts, radii and contours to template.
 - b. Smooth edges.
 - c. Repair or reject defective and inaccurate work.

2.5 FINISHES

- A. Select from the manufacturer's standard color chart.
 - 1. Color:
 - a. To be selected from manufacturer standard color chart.
- B. Finish:
 - 1. Provide surfaces with a uniform finish.
 - a. Matte; gloss range of 5–20.
 - 1) To be selected from manufacturer standard range.

PART 3 — EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with fabricator present 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 INSTALLATION

- A. Install components plumb, level and rigid, scribed to adjacent finishes, in accordance with approved shop drawings and product data.
 - 1. Provide product in the largest pieces available.
 - 2. Form field joints using manufacturer's recommended adhesive, with joints inconspicuous in finished work.
 - a. Exposed joints/seams shall not be allowed.
 - 3. Reinforce field joints with solid surface strips extending a minimum of 1 inch on either side of the seam with the strip being the same thickness as the top.
 - 4. Cut and finish component edges with clean, sharp returns.
 - 5. Rout radii and contours to template.
 - 6. Anchor securely to base cabinets or other supports.
 - 7. Align adjacent countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop.
 - 8. Carefully dress joints smooth, remove surface scratches and clean entire surface.
 - 9. Install countertops with no more than 1/8-inch (3 mm) sag, bow or other variation from a straight line.

3.3 REPAIR

- A. Repair or replace damaged work which cannot be repaired to architect's satisfaction.

3.4 CLEANING AND PROTECTION

- A. Keep components clean during installation.
- B. Remove adhesives, sealants and other stains.

END OF SECTION 066510

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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. Rock-fiber insulation.
 - 3. Roof Insulation
 - 4. Batt Insulation

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.
- B. Research/Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.5 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration by 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 plastic insulation as follows:
 - 1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
 - 2. Protect against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.
 - 3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 FOAM-PLASTIC BOARD INSULATION

- A. Extruded-Polystyrene Board Insulation: ASTM C 578, of type and minimum compressive strength indicated below, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.
 - 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. DiversiFoam Products.
 - b. Dow Chemical Company.
 - c. Owens Corning.
 - d. Pactiv Building Products.
 - 2. Type IV, 25 psi. at perimeter foundation walls and under slab.
- B. Foil-Faced, Polyisocyanurate Board Insulation: ASTM C 1289, Type I, Class 1, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.
 - 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. Atlas Roofing Corporation.
 - b. Dow Chemical Company (The).
 - c. Rmax, Inc.

- C. Adhesive: Type recommended by board insulation manufacturer and waterproofing manufacturer.

2.2 ROCKWOOL INSULATION

- A. Rockwool Insulation: ASTM C 612, with flame-spread index of 0 and smoke-developed index of 0, respectively, per ASTM E 84 and UL 723.
 - 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. ROCKWOOL (ROXUL).
 - b. American Rockwool. Rockwool Group.

2.3 ROOF INSULATION

- A. General: Preformed roof insulation boards manufactured or approved by roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated.
- B. Provide ½" Thick SECUROCK gypsum fiber roof board mechanically fastened through to metal deck.
- C. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class I, Grade 3, felt or glass-fiber mat facer on both major surfaces.
- D. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches and 1/8 inch per 12 inches at locations indicated on the drawings.
- E. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.
- F. Refer to drawings for insulation thicknesses.
- G. Provide ¼" thick SECUROCK gypsum fiber roof board attached to the insulation using hot asphalt, type 3.

2.4 BATT INSULATION (Interior steel stud application)

- A. Batt insulation: ASTM C423, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.

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: ROCKWOOL AFB or equivalent product from; Owens Corning; Johns Manville.

2.5 INSULATION ACCESSORIES

- A. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with roofing system.
- 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 and cover boards to substrate, and acceptable to roofing system manufacturer.

2.6 INSULATION FASTENERS

- A. Type recommended by insulation manufacturer for insulation types, and applications specified.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce

thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.3 INSTALLATION OF BELOW-GRADE INSULATION

- A. On vertical surfaces, set insulation units using manufacturer's recommended adhesive applied according to manufacturer's written instructions.
 - 1. If not otherwise indicated, extend insulation a minimum of 24 inches below exterior grade line.
- B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.
 - 1. If not otherwise indicated, extend insulation a minimum of 24 inches below exterior grade line.

3.4 INSTALLATION OF INSULATION FOR FRAMED CONSTRUCTION

- A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.
- B. Foam-Plastic Board Insulation: Seal joints between units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.
- C. Glass-Fiber 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.

3.5 PROTECTION

- A. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. 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 072100

SECTION 075000 - MEMBRANE ROOFING CUTTING AND PATCHING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. General requirements for cutting and patching roofing membranes to accommodate changes or modifications to roof mounted equipment.
- B. Related Sections:
 - 1. Division 01 Section "Cutting and Patching" for other requirements related to cutting and patching.
 - 2. Division 07 Section "Modified Bituminous Membrane Roofing".
 - 3. Division 07 Section "Roof Accessories".

1.2 DEFINITIONS

- A. OEM: Original manufacturer for installed roofing systems.

1.3 SYSTEM DESCRIPTION

- A. Modified membrane patching meeting the OEM requirements for integration into existing roof system and continuance of warranty.
 - 1. 80-mil modified bitumen base sheet and 160-mil mineral surface modified bitumen cap sheet in field
 - 2. 40-mil modified bitumen base sheet and 160-mil mineral surface modified bitumen cap sheet at curb flashings
 - 3. All plies fully bonded with cold-process asphalt adhesive

1.4 PERFORMANCE REQUIREMENTS

- A. Weatherproof Integrity: Cutting and patching of membrane roofing for new curbs, installation of decking and new roofing after equipment removal, and other roof penetration flashings shall maintain the weather integrity of the existing roofs and shall not permit concealed or visible leaks into the building interior.
 - 1. Comply with the current published requirements of the OEM for roof penetrations of the type necessary for the work.

1.5 SUBMITTALS

- A. Product Data: For each type of product employed in the Work.
- B. Shop Drawings: For roofing penetrations. Provide OEM standard details and modified details where required for the conditions of the work.
- C. Manufacturer's certificates: Signed by roofing system manufacturer certifying that the roofing system complies with requirements specified. Provide evidence of

acceptance by OEM manufacturer of proposed changes to existing roof system, installation procedures for all roof membrane, and documentation that contractor is authorized by OEM to install their products.

- D. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by OEM.
- B. Manufacturer's Representative Qualifications: OEM's authorized representative who is trained and knowledgeable in the installation of units required for this Project.
- C. Preinstallation Conference: Conduct conference at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store roofing materials in a dry, well-ventilated, weather tight location to ensure no significant moisture pickup and maintain at a temperature exceeding roofing system manufacturer's written instructions. Store rolls of felt and other sheet materials on end on pallets or other raised surfaces. Do not double-stack rolls.
 - 1. Handle and store roofing materials and place equipment in a manner to avoid significant or permanent damage to deck or structural supporting members.
- B. Do not leave unused felts and other sheet materials on the roof overnight or when roofing work is not in progress unless protected from weather and moisture and unless maintained at a temperature exceeding 50 deg F (10 deg C).
- C. Deliver and store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.
- D. Protect roofing insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

1.8 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with roofing work only when existing and forecasted weather conditions permit roofing to be installed according to manufacturers' written instructions and warranty requirements. Do not install roofing products on roofs that are wet.

1.9 WARRANTY

- A. Where existing roof is still under OEM warranty, comply with the requirements of the OEM to maintain such warranty:

PART 2 - PRODUCTS

2.1 MATERIALS AND PRODUCTS

- A. General: Provide and employ products only as approved by OEM for the type of roofing involved. Where new products are added to existing roofs, use materials of quality level at least as high as the originally installed materials.
- B. Manufacturers: Provide materials by OEM manufacturer to match existing roof system and warranty requirements.
 - 1. Garland Company, Inc.

2.2 Modified Built Up Roof System Base Sheet

- A. Base Ply of Field System: Flexbase 80: SBS modified bituminous sheet (Styrene-Butadiene- Styrene) 80 mil, smooth surfaced rubber modified roofing membrane reinforced with a dual fiberglass scrim.
 - 1. Use: Base ply of 2-ply, modified bituminous membrane roofing system.
 - 2. Reinforcing: Fiberglass.
 - 3. Finish: smooth and sanded
- B. Physical Properties: Provide SBS -modified bituminous membrane materials with the following properties when tested according to ASTM D 5147:
 - 1. Thickness: 80 mils minimum.
 - 2. Tensile Strength: 225 bf/in. at 73.4 deg F (MD). 225 lbf/in. at 73.4deg F (CMD).
 - 3. Elongation at Maximum Load: 7 percent minimum at 73.4 deg F in each direction.
 - 4. Tear Strength: 300 lbf. at 73.4 deg. F (MD). 300 lbf. at 73.4 deg. F (CMD).
 - 5. Low-Temperature Flexibility: Pass at minus 30 deg F.

2.3 Modified Built Up Roof System Flashing Base Sheet

- A. Base Ply of Flashing System: VersiPly 40: SBS modified bituminous sheet (Styrene-Butadiene- Styrene) 40 mil, smooth surfaced rubber modified roofing membrane reinforced with a dual fiberglass mat.
 - 1. Use: Base ply of 2-ply, modified bituminous membrane flashing system.
 - 2. Reinforcing: Fiberglass.
 - 3. Finish: smooth
- B. Physical Properties: Provide SBS -modified bituminous membrane materials with the following properties when tested according to ASTM D 5147:
 - 1. Thickness: 40 mils minimum.
 - 2. Tensile Strength: 215 bf/in. at 73.4 deg F (MD). 215 lbf/in. at 73.4deg F (CMD).

3. Elongation at Maximum Load: 4.5 percent minimum at 73.4 deg F in each direction.
4. Tear Strength: 275 lbf. at 73.4 deg. F (MD). 275 lbf. at 73.4 deg. F (CMD).
5. Low-Temperature Flexibility: Pass at minus 30 deg F.

2.4 Modified Built Up Roof System Cap Sheet

- A. SBS/SIS modified bituminous sheet: StressPly E: 160 mil mineral surfaced rubber modified roofing membrane reinforced with a dual fiberglass and polyester scrim mat.
 1. Use: Roof membrane.
 2. Use: Finish ply of 2-ply, modified bituminous membrane roofing system.
 3. Reinforcing: Polyester and fiberglass.
 4. Finish: light grey mineral
- B. Physical Properties: Provide SBS/SIS-modified bituminous membrane materials with the following properties when tested according to ASTM D 5147:
 1. Thickness: 160 mils minimum.
 2. Tensile Strength: 500 lbf/in. at 73.4 deg F (MD). 550 lbf/in. at 73.4deg F (CMD).
 3. Elongation at Maximum Load: 6.0 percent minimum at 73.4 deg F in each direction.
 4. Tear Strength: 900 lbf. at 73.4 deg. F (MD). 950 lbf. at 73.4 deg. F (CMD).
 5. Low-Temperature Flexibility: Pass at minus 40 deg F.

2.5 Modified Built Up Roof System Cap Sheet (Memorial School Millennium membrane cap sheet)

- A. SBS modified coal tar bituminous sheet (Styrene-Butadiene- Styrene) 160 mil, mineral surfaced rubber modified roofing membrane reinforced with a dual fiberglass and polyester scrim mat.
 1. Use: Roof membrane.
 2. Use: Finish ply of 2-ply, modified bituminous membrane roofing system.
 3. Reinforcing: Polyester and fiberglass.
 4. Finish: light grey mineral
- B. Physical Properties: Provide SBS/SIS-modified bituminous membrane materials with the following properties when tested according to ASTM D 5147:
 1. Thickness: 160 mils minimum.
 2. Tensile Strength: 310 lbf/in. at 73.4 deg F (MD). 310 lbf/in. at 73.4deg F (CMD).
 3. Elongation at Maximum Load: 3.5 percent minimum at 73.4 deg F in each direction.
 4. Tear Strength: 500 lbf. at 73.4 deg. F (MD). 480 lbf. at 73.4 deg. F (CMD).

5. Low-Temperature Flexibility: Pass at minus 58 deg F.

2.6 Modified Adhesives and Mastics

- A. Cold Applied Membrane Adhesive and Flood Coat Adhesive: V.O.C. compliant
ASTM D3019. Performance Requirements:
 1. Non-Volatile Content ASTM D4479 70%
 2. Density ASTM D1475 7.89 lbs./gal. (0.9kg/l)
 3. Viscosity Stormer ASTM D562 16-20 sec.
 4. Flash Point ASTM D93 100°F min. (37°C)
 5. Slope: up to 3:12
- B. Brush Grade Flashing Adhesive Weather-King Flashing Adhesive
 1. Performance Requirements:
 2. Non-Volatile Content ASTM D4479 70% min.
 3. Density ASTM D1475 8.6 lbs./gal. (1kg/l)
 4. Flash Point ASTM D93 100°F (37°C)
- C. Silver Asphalt Roofing Mastic: V.O.C. compliant,
 1. Flash Point ASTM D93 >100 °F.
 2. Density @ 77°F 8.3 lbs. /gal
 3. Non-Volatile 70% min.
 4. Viscosity @ 77 °F mobilometer 1500g 9-11 seconds
 5. Reflectivity: 60%
 6. Post Industrial Recycled Content 5.19%
- D. Flashing Bond Mastic: V.O.C. compliant
 1. Non-Volatile Content ASTM D4479 70%
 2. Density ASTM D1475 7.89 lbs./gal. (0.9kg/l)
 3. Viscosity Stormer ASTM D562 16-20 sec.
 4. Flash Point ASTM D93 100°F min. (37°C)
 5. Slope: up to 3:12

2.7 AUXILIARY MEMBRANE MATERIALS

- A. General: Furnish auxiliary materials recommended by roofing system manufacturer for intended use and compatible with SBS-modified bituminous roofing.
 1. Furnish liquid-type auxiliary materials that meet VOC limits of authorities having jurisdiction.
- B. Asphalt Primer: Garla-Prime VOC: ASTM D 41 - VOC compliant.

- C. Asphalt Roofing Cement: Flashing Bond: ASTM D 2822, asbestos free, VOC compliant as provided by the Membrane manufacturer and silver in color throughout the thickness
- D. Mastic Sealant: Polyisobutylene, plain or modified bituminous, nonhardening, nonmigrating, nonskinning, and nondrying.
- E. Fasteners: Factory-coated steel fasteners and metal plates complying with corrosion-resistance provisions of FM 4470; designed for fastening base sheets, base-ply felts, and base flashings and for backnailing modified bituminous membrane to substrate; tested by manufacturer for required pullout strength; and acceptable to roofing system manufacturer.
- F. Wood Nailer Strips: Furnish wood nailer strips complying with requirements of Division 6 Section "Rough Carpentry."
- G. Cants: Wood Fiber Cants
- H. Urethane Sealant: Tuff-Stuff MS: One part, non-sag sealant as recommended and furnished by the membrane manufacturer for moving joints.
 - 1. Tensile Strength (ASTM D412) 225 psi
 - 2. Elongation (ASTM D412) 450%
 - 3. Hardness, Shore A (ASTM C920) 25-35
 - 4. Bond Durability – Class 25 (ASTM C920) Passes
- I. Liquid Flashing: Tuff-Flash Plus LO: A two-component, asphaltic-polyurethane, low odor, liquid flashing material designed for specialized details unable to be waterproofed with typical modified membrane flashings. Must be painted when cured.
 - 1. Tensile Strength (ASTM D412) 650 psi
 - 2. Elongation (ASTM D412) 325%
 - 3. Density @77°F 8.3 lb/gal typical
- J. Energy Star Acrylic Surfacing: Pyramic Plus LO; For use on all liquid flashing details. Energy Star approved white acrylic roof coating ASTM G26 with 81% reflectivity, 250% Minimum elongation and 250 psi tensile strength.
 - 1. Weight/Gallon 12 lbs./gal. (1.44 g/cm³)
 - 2. Non-Volatile % (ASTM D 1644) 66 min
- K. Pitch Pocket Sealer: Use Liquid Flashing in lieu of pitch pockets wherever practical. Where pitch pockets are needed, use specified Liquid Flashing product to fill pitch pockets.
- L. Pitch pans, Rain Collar 24 gauge stainless or 20oz (567gram) copper. All joints should be welded/soldered watertight. See details for design
- M. Drain Flashings should be 4lb (1.8kg) sheet lead formed and rolled
- N. Plumbing stacks should be 4lb (1.8kg) sheet lead formed and rolled.

- O. Miscellaneous Accessories: Provide miscellaneous accessories recommended by roofing system manufacturer for intended use.

2.8 INSULATION MATERIALS

- A. General: Provide preformed roofing insulation boards for deck infill areas that comply with requirements, in thickness selected to match existing surrounding roof system height. Adjust depth as required to account for variance in roof decking where new work matches existing roofing. Provide uniform thickness or tapered insulation according to existing roof construction.
- B. Polyisocyanurate Rigid Board Insulation: Rigid, cellular Polyisocyanurate thermal insulation with core formed by using HCFCs as blowing agents complying with ASTM C 1289, classified by facer type as follows:
 - 1. Facer Type: Type II, felt or glass-fiber mat on both major surfaces.
 - 2. Match height and/or tapered design of existing polyisocyanurate insulation. Refer to roof plan.
- C. Cover Board
 - 1. Provide ½" thick high density wood fiber cover board or gypsum cover board. Selection should match existing construction.

2.9 INSULATION ACCESSORIES

- A. General: Furnish roofing insulation accessories recommended by insulation manufacturer for intended use and compatible with sheet roofing material.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions of FM 4470, designed for fastening roofing insulation to substrate, tested by manufacturer for required pullout strength, and acceptable to roofing system manufacturer.
- C. Tapered Edge Strips: Rigid, cellulosic-fiber insulation board, complying with ASTM C 208, Type 2.
- D. Insulation Board Adhesive: Two component, foam adhesive as recommended by roof manufacturer and approved by FM indicated ratings.
 - 1. Tensile Strength (ASTM D412) 250 psi
 - 2. Density (ASTM D1875) 8.5 lbs./gal.
 - 3. Viscosity (ASTM D2556) 22,000 to 60,000 cP.
 - 4. Peel Strength (ASTM D903) 17 lb/in.
 - 5. Flexibility (ASTM D816) Pass @ -70°F

2.10 PROTECTION/WALKWAY PADS

- A. Factory formed recycled rubber, nonporous, with a slip-resisting surface texture, manufactured specifically for adhering to modified bituminous membrane roofing as a protection course for foot traffic or for protection beneath sleepers, pedestals, or supports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roofing membranes and affected flashings before installation. Inform Owner of existing conditions that could cause leaks that may be misconstrued as the result of the new work.

3.2 PREPARATION

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

3.3 ROOFING MEMBRANE CUTTING AND PATCHING

- A. General: Provide the highest quality roof patches that comply with the OEM requirements. Provide redundancy in weather proof membrane where possible.
- B. Coordinate all work with work of other trades.
- C. Lap new material onto old roofing material 12" minimum. Seal all junctions of new membrane to old membrane with 3-course mastic and mesh, except in areas to be coated with reinforced urethane system.
- D. Provide positive drainage so that no detail or part of roof is required to resist ponded water.
- E. Provide overlaps at counter flashings of minimum dimension to resist wind-blown rain.
- F. Do not use pitch pockets without secondary sheet metal hood.

3.4 PROCEDURES FOR ADDITIONS/ALTERATIONS TO EXISTING MINERAL SURFACED ROOFS

- A. Preparation For New Curbs
 1. Identify the location of each new curb to be installed, coordinating with mechanical contractor.
 2. Clean the roof surface within area of new curb, removing all debris, loose mineral, or dirt.
 3. Cut out and remove the roof system and all insulation layers down to the structural deck. Use a stiff bristled broom and blower to clear away all dirt and debris from the work area.

- B. Flashing New Curbs
1. New curb shall be set with minimum flashing height of 8" or greater above finished roof surface. Install wood blocking if needed to increase height of curb.
 2. Install cant strip to the base of the curb set in Flashing Bond adhesive.
 3. Prime the existing roof surface around the curb with Garla-Prime VOC to ensure proper adhesion. Apply at ½ gallon per 100 sq. ft. and allow to dry.
 4. Install the Versiply 40 base sheet flashing ply, followed by the Stressply E cap sheet to the curb in a solid application of specified flashing adhesive.
 - a. Flashing Bond
 5. Both flashing plies should extend up and over the curb. Fasten flashing plies to the top of the curb with cap nails. The base ply should extend onto the field a minimum of 6", with the cap ply extending 3" beyond the base ply.
 6. Apply three course reinforcement of Gar-Mesh and Silver Flash on vertical seams.
 7. Allow new flashing membrane installation with Weatherking to cure 7 days minimum.
 8. Install new equipment and securely fasten to the curb.
- C. Flashing New Metal Curbs, Pitch Pockets, Lead Sleeves, and Equipment Stands (Stress-Ply Roof membranes)
1. Prime surface of existing roof with Garla-Prime or approved equal.
 2. Set the flange of the flashing or the lead pan into an application of Flashing Bond asphalt mastic. Nail the flange 3" O.C. into the wood blocking.
 3. Flash the flange with base and cap modified membrane stripping set in specified adhesive. Install the base ply to extend beyond the flange a minimum of 6". The second ply should extend beyond the first a minimum of 3".
 - 1) For cold adhesives, apply 2-3 gal/100 sq. ft.
 4. Match surfaces:
 - a. Paint surface of curb with appropriate roof coating to match existing, if necessary.
 - b. On white mineral surfaced roofs, ensure loose minerals are broadcast into the bleed out of flashing adhesive.
 5. All pitch pockets shall be filled with pourable sealer.
 6. A hood or storm collar will be fabricated to cover all pitch pockets and sleeves as shown in the detail drawing.
 7. The hood may be attached to the projection with a draw band or by welding.
 8. Prime surface of existing roof with Garla-Prime or approved equal.
 9. Set the flange of the flashing or the lead pan into an application of Flashing Bond asphalt mastic. Nail the flange 3" O.C. into the wood blocking.
 10. Flash the flange with base and cap modified membrane stripping set in specified adhesive. Install the base ply to extend beyond the flange a minimum of 6". The second ply should extend beyond the first a minimum of 3".
 - a. For cold adhesives, apply 2-3 gal/100 sq. ft.

11. Match surfaces:
 - a. Paint surface of curb with appropriate roof coating to match existing, if necessary.
 - b. On white mineral surfaced roofs, ensure loose minerals are broadcast into the bleed out of flashing adhesive.
12. All pitch pockets shall be filled with pourable sealer.
13. A hood or storm collar will be fabricated to cover all pitch pockets and sleeves as shown in the detail drawing.
14. The hood may be attached to the projection with a draw band or by welding.

D. Infill of Roofing after Equipment Removal

1. New decking shall be installed in all roof openings after removal of curbs.
2. Provide insulation matching up to height of existing roof assembly, including tapered boards as required to maintain roof drainage design. Properly matched tapered insulation must be provided as required to match existing tapered layout, provide for continuation of crickets, sumps, or other features of existing roof drainage design.
3. Mechanically fasten polyisocyanurate boards to metal deck using 11 fasteners per 4x8 board in Zone 1 of the roof. Increase fastening rate for work in Zone 2 (roof perimeter) to 17 fasteners per 4x8 board and in Zone 3 (corners) to 22 fasteners per board.
4. Subsequent layers of polyisocyanurate shall be adhered with Insul-Lock HR, $\frac{3}{4}$ " beads applied 12" on center. Increase rate to 6" on center in Zone 2 and 4" on center in Zone 3.
5. All layers of insulation should be adhered on concrete roof decks. Follow above-referenced insulation adhesive pattern.
6. Install $\frac{1}{2}$ " roof cover board, adhered with Insul-Lock HR using the above-described fastening pattern. Ensure boards are set and properly bonded with edges flush and tightly fitted. Fill all gaps in insulation exceeding $\frac{1}{4}$ " thick.
7. Install new roofing with all plies shingled in the direction of water. Stagger laps between base sheet and cap sheet.
8. Install new base ply (Flexbase 80) solidly bonded to the cover board with Weatherking adhesive at the rate of 2 gallons per 100 sq. ft. Broom or roll top of membrane to ensure bond with adhesive and eliminate wrinkles or trapped air.
9. Lap base sheet onto existing roof 8" minimum.
10. Install cap sheet (StressPly E Mineral) solidly bonded over the base sheet with Weatherking adhesive at the rate of 2 gallons per 100 sq. ft. Broom or roll top of membrane to ensure bond with adhesive and eliminate wrinkles or trapped air. Lap cap sheet onto existing roof 4" minimum beyond edge of base sheet.
11. Flood coat area with Weatherking and broadcast gravel into flood coat.

E. Liquid Flashing Application

1. Provide manufacturer's liquid flashing (Tuff-Flash Plus LO, reinforced with Polyester Soft) at all roof penetration details such as pipe penetrations, conduit feeds, dunnage posts, etc.
2. Fill all gaps around projections with insulation and new roofing membrane before flashing work.
3. Mask target area on roof membrane with tape.
4. Clean all non-porous areas with isopropyl alcohol. Remove asphalt or adhesive residue from projections. Prepare existing urethane coated roofing with acetone solvent wipe.
5. Apply 32 wet mils base coat of liquid flashing over masked area and encasing projection, minimum 4" high above finished roof.
6. Embed polyester reinforcement fabric into the base coat of the liquid flashing.
7. Apply 48-64 wet mil top coat of the liquid flashing material over the fabric extending 2" past the scrim in all directions.
8. Apply minerals immediately or allow the liquid flashing material to cure 15-30 days and then install reflective coating (Pyramic Plus LO)

3.5 FIELD QUALITY CONTROL

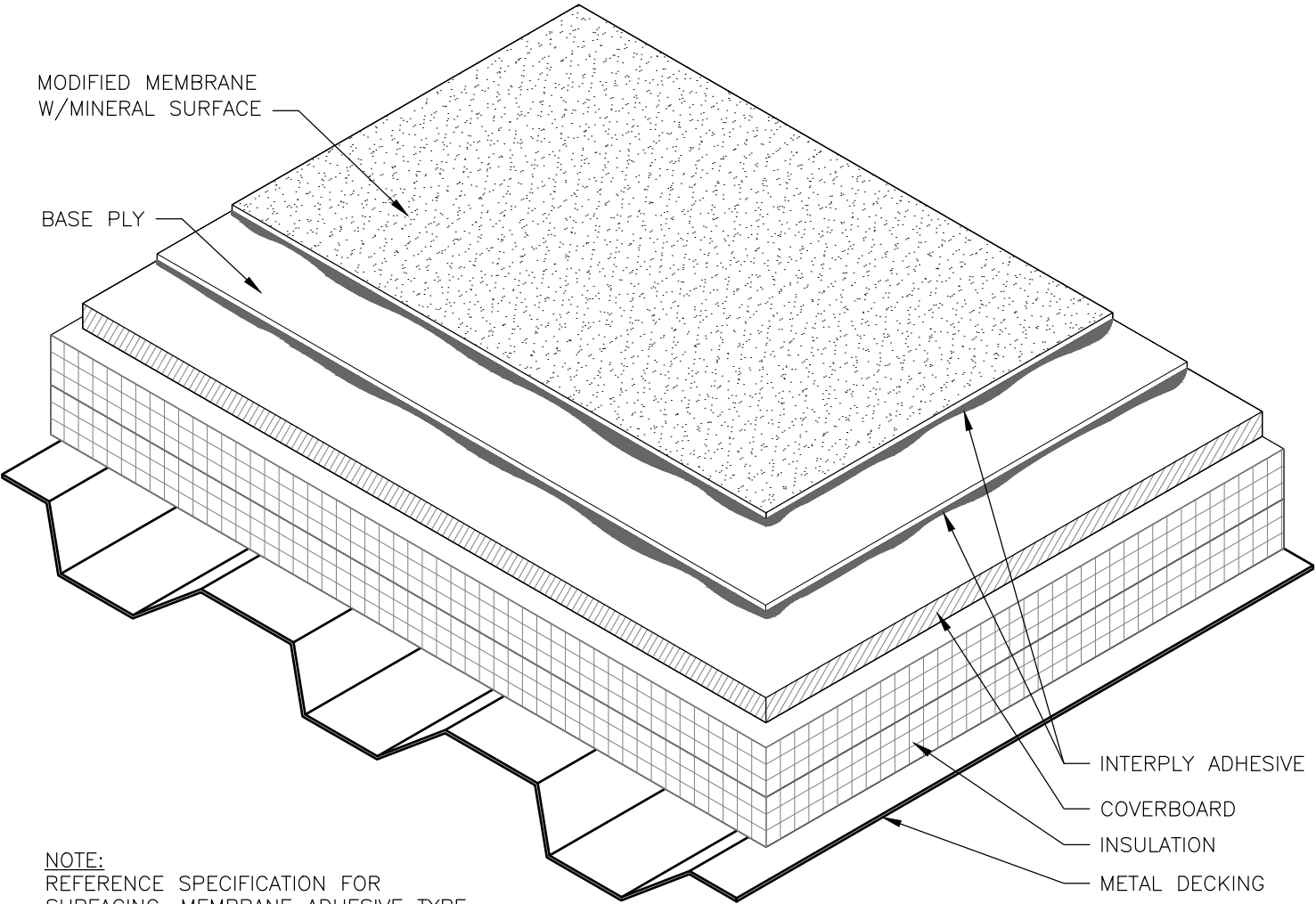
- A. Manufacturer's Representative: Review installed work and determine if work meets the highest OEM standards. Provide written confirmation of work completed and compliance with OEM requirements, including warranty provisions, where applicable.
- B. Contractor: Notify manufacturer's representative of work before starting to coordinate for inspections by the representative during the installation. Schedule a final inspection once all work is complete. A copy of the final inspection will be provided to the Architect and the Owner.

3.6 PROTECTING AND CLEANING

- A. Protect modified bituminous membrane roofing from damage and wear during construction period. Adjacent roof areas must be fully protected from construction activities and traffic using means and methods approved by manufacturer holding the existing warranty. Provide minimum 2" extruded polystyrene insulation and 1/2" plywood protection laid down over any existing roofs to remain that will be used for transport of materials or personnel access to construction areas. Limit storage of materials to in-contract roof areas. Engage warranty holder for a post-construction inspection any roofs that may have been affected by construction traffic.
- B. Correct deficiencies in or remove modified bituminous roofing that does not comply with requirements, repair substrates, reinstall roofing, and repair base flashings to a condition free of damage and deterioration at the time of Substantial Completion and according to warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 075 00

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NOTE:
REFERENCE SPECIFICATION FOR
SURFACING, MEMBRANE ADHESIVE TYPE,
AND INSULATION/COVER BOARD TYPE
AND ATTACHMENT METHOD.

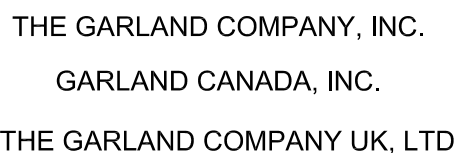
DRAWINGS ON 8½"x11 TITLE BLOCKS ARE NOT TO SCALE.

TYPICAL ROOF SYSTEM MINERAL SURFACE



THE GARLAND COMPANY, INC.
GARLAND CANADA, INC.
THE GARLAND COMPANY UK, LTD

PROJECT:	
CUSTOMER:	
ARCHITECT:	
REPRESENTATIVE:	
DATE:	SHT: OF



CURB DETAIL/AIR HANDLING STATION

HOT APPLIED

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 Section Includes:

- 1. Penetrations in fire-resistance-rated walls.
- 2. Penetrations in horizontal assemblies.

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 qualified testing and inspecting agency.
 - 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."
 - 3) FM Global in its "Building Materials Approval Guide."
- C. Preinstallation 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.
- C. Notify Owner's testing agency at least seven days in advance of penetration firestopping installations; confirm dates and times on day preceding each series of installations.

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. A/D Fire Protection Systems Inc.
 2. Grace Construction Products.

3. Hilti, Inc.
4. Johns Manville.
5. Nelson Firestop Products.
6. RectorSeal Corporation.
7. Specified Technologies Inc.
8. 3M Fire Protection Products.
9. Tremco, Inc.; Tremco Fire Protection Systems Group.
10. 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.
 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.
 1. Horizontal assemblies include floors, floor/ceiling assemblies, and ceiling membranes of roof/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. W-Rating: Provide penetration firestopping showing no evidence of water leakage when tested according to UL 1479.
- E. 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.
- F. 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 nonshrinking, 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, nonshrinking 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's 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 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. Owner will engage a qualified testing agency to perform tests and inspections.
- B. Where deficiencies are found or penetration firestopping is damaged or removed because of testing, repair or replace penetration firestopping to comply with requirements.
- C. 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.

END OF SECTION 078413

SECTION 078446 - FIRE-RESISTIVE JOINT SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Joints in or between fire-resistance-rated constructions.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Schedule: For each fire-resistive joint system. Include location and design designation of qualified testing agency.
 - 1. Where Project conditions require modification to a qualified testing agency's illustration for a particular fire-resistive joint system condition, submit illustration, with modifications marked, approved by fire-resistive joint system 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 fire-resistive joint systems have 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 fire-resistive joint systems.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A firm experienced in installing fire-resistive joint systems 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 fire-resistive joint system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.
- B. Fire-Test-Response Characteristics: Fire-resistive joint systems shall comply with the following requirements:
 - 1. Fire-resistive joint system tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
 - 2. Fire-resistive joint systems are identical to those tested per testing standard referenced in "Fire-Resistive Joint Systems" Article. Provide rated systems complying with the following requirements:
 - a. Fire-resistive joint system products bear classification marking of qualified testing agency.
 - b. Fire-resistive joint systems correspond to those indicated by reference to designations listed by the following:
 - 1) UL in its "Fire Resistance Directory."
- C. Preinstallation Conference: Conduct conference at Project site.

1.6 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. Install and cure fire-resistive joint systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.7 COORDINATION

- A. Coordinate construction of joints to ensure that fire-resistive joint systems are installed according to specified requirements.
- B. Coordinate sizing of joints to accommodate fire-resistive joint systems.
- C. Notify Owner's testing agency at least seven days in advance of fire-resistive joint system installations; confirm dates and times on day preceding each series of installations.

PART 2 - PRODUCTS

2.1 FIRE-RESISTIVE JOINT SYSTEMS

- A. Where required, provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which fire-resistive joint systems are installed. Fire-resistive joint systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.
- B. Joints in or between Fire-Resistance-Rated Construction: Provide fire-resistive joint systems with ratings determined per ASTM E 1966 or UL 2079:
 - 1. Joints include those installed in or between fire-resistance-rated walls, floor or floor/ceiling assemblies, and roofs or roof/ceiling assemblies.
 - 2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of construction they will join.
 - 3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Fibrex Insulations, Inc.
 - b. Passive Fire Protection Partners.
 - c. 3M Fire Protection Products.
 - d. Thermafiber Corp.
 - e. Roxul Inc.
 - f. USG Corporation.
- C. Exposed Fire-Resistive Joint Systems: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- D. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install fill materials and to maintain ratings required. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing agency for systems indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Surface Cleaning: 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 the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing fire-resistive joint system's seal with substrates.

3.3 INSTALLATION

- A. General: Install fire-resistive joint systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming materials and other accessories of types required to support fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.
- C. Install fill materials for fire-resistive joint systems by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by joints and forming 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 the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

- A. Identify fire-resistive joint systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of joint edge so labels will be visible to anyone seeking to remove or penetrate joint system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
 1. The words "Warning - Fire-Resistive Joint System - Do Not Disturb. Notify Building Management of Any Damage."
 2. Contractor's name, address, and phone number.
 3. Designation of applicable testing agency.
 4. Date of installation.
 5. Manufacturer's name.
 6. Installer's name.

3.5 FIELD QUALITY CONTROL

- A. Inspecting Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Where deficiencies are found or fire-resistive joint systems are damaged or removed due to testing, repair or replace fire-resistive joint systems so they comply with requirements.
- C. Proceed with enclosing fire-resistive joint systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTING

- A. Clean off excess fill materials adjacent to joints as the 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 joints 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.

3.7 FIRE-RESISTIVE JOINT SYSTEM SCHEDULE

- A. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHBN.

END OF SECTION 078446

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Silicone joint sealants.
 - 2. Urethane joint sealants.
 - 3. Polysulfide joint sealants.
 - 4. Latex joint sealants.
 - 5. Solvent-release-curing joint sealants.
 - 6. Preformed joint sealants.
 - 7. Acoustical joint sealants.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Samples: For each kind and color of joint sealant required.
- C. Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, and designation.
 - 2. Joint-sealant manufacturer and product name.
 - 3. Joint-sealant formulation.
 - 4. Joint-sealant color.

1.5 INFORMATIONAL SUBMITTALS

- A. Product test reports.
- B. Preconstruction compatibility and adhesion test reports.
- C. Preconstruction field-adhesion test reports.
- D. Field-adhesion test reports.
- E. Sample warranties.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM C 1021 to conduct the testing indicated.

1.7 PRECONSTRUCTION TESTING

- A. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates. Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1.1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.

1.8 WARRANTY

- A. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.
1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

- A. Silicone, S, NS, 100/50, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 100/50, 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. Momentive Performance Materials; GE Construction Sealants; SCS2700 SilPruf LM .
- b. Sika Corporation U.S.; Sikasil WS-290.

- B. Silicone, S, NS, 50, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, 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; 791.
 - b. Momentive Performance materials; GE Construction Sealants; SCS2000 SilPruf.
 - c. May National Associates, Inc., a subsidiary of Sika Corporation U.S.; Bondaflex Sil 265 LTS.
 - d. Pecora Corporation; PCS.
 - e. Sika Corporation U.S.; Sikasil WS-295.
- C. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.
1. 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; 758.
 - b. Momentive Performance Materials; GE Construction Sealants; SCS2350.
 - c. Polymeric Systems, Inc.; PSI-631.
 - d. Schnee-Morehead, Inc., an ITW company; SM5731 Poly-Glaze Plus.
- D. Silicone, S, NS, 100/50, T, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 100/50, Uses T and 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; NS.
 - b. May National Associates, Inc., a subsidiary of Sika Corporation U.S.; Bondaflex Sil 728 NS.
- E. Silicone, S, NS, 50, T, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Uses T and NT.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dow Corning Corporation; 799.
 - b. Soudal USA; RTV 50.
- F. Silicone, S, NS, 25, T, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Uses T and 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. May National Associates, Inc., a subsidiary of Sika Corporation U.S.; Bondaflex Sil 199 PG.
- b. Sika Corporation U.S.; Sikasil-N Plus US.

2.3 NONSTAINING SILICONE JOINT SEALANTS

- A. Nonstaining Joint Sealants: No staining of substrates when tested according to ASTM C 1248.
- B. Silicone, Nonstaining, S, NS, 100/50, NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 100/50, 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. May National Associates, Inc., a subsidiary of Sika Corporation U.S.; Bondaflex Sil 290 FPS-NB.
 - b. Pecora Corporation; 890FTS/TXTR, or 890 NST.
 - c. Tremco Incorporated; Spectrem 1.
- C. Exterior Silicone, Nonstaining, S, NS, 50, NT: Nonstaining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, 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. Pecora Corporation; 864NST.
 - b. Dow Corning Corporation; 795.
 - c. Momentive Performance Materials; GE Construction Sealants; SilPruf NB.
 - d. Tremco Incorporated; Spectrem 2.
 2. Applications: Use for exterior non-traffic bearing joints:
 - a. Control and soft joints in masonry.
 - b. Joints between concrete or stone and other materials.
 - c. Joints between metal frames and other materials.
 - d. Other exterior non-traffic bearing joints for which no other sealant is indicated.
- D. Exterior Silicone (EIFS Systems), Nonstaining, S, NS, 100/50, T, NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 100/50, Uses T and 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. Pecora Corporation; 890HST.
 - b. Dow Corning Corporation; 790.
 - c. Momentive performance Materials; GE Construction Sealants; SilPruf NB.
 - d. Tremco Incorporated; Spectrem 1.

- E. Silicone, Nonstaining, M, NS, 50, NT: Nonstaining, multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type M, Grade NS, Class 50, 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. Tremco Incorporated; Spectrem 4-TS.

2.4 URETHANE JOINT SEALANTS

- A. Interior Urethane, S, NS, 25, NT: Single-component, nonsag, nontraffic-use, plus 25 percent and minus 25 percent movement capability, urethane joint sealant; ASTM C 920, Type S, Grade NS, Class 25, 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. Pecora Corporation; Dynatrol I-XL.
 - b. Sherwin-Williams Company (The); Stampede-1.BASF Construction Chemicals, LLC, Building Systems; Sonalastic TX1.
 - c. Tremco Incorporated; Dymonic.
 - 2. Applications: Use for:
 - a. Interior wall and ceiling control joints.
 - b. Joints between interior surfaces and exterior wall components.
 - c. Other interior dynamic joints.
- B. Urethane, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and 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 Construction Chemicals, LLC, Building Systems; Sonolastic SL 1.
 - b. Pecora Corporation; NR-201.
 - c. Polymeric Systems, Inc.; Flexiprene 952.
 - d. Schnee-Morehead, Inc.; an ITW company; Permthane SM7101.
 - e. Sherwin-Williams Company (The); Stampede 1SL.
- C. Urethane, M, NS, 50, NT: Multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability nontraffic-use, urethane joint sealant; ASTM C 920, Type M, Grade NS, Class 50, 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. Pecora Corporation; Dynatrol II.
- D. Urethane, M, NS, 25, NT: Multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C 920, Type M, Grade NS, Class 25, Use NT.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Sherwin-Williams Company (The); Stampede-2NS.
- E. Exterior Urethane, M, NS, 50, T, NT: Multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type M, Grade NS, Class 50, Uses T and 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. Tremco Incorporated; Dymeric 240.
 - b. BASF Building Systems; Sonneborn; NP 2.
 2. Applications: Use for exterior non-traffic bearing joints, except EIFS joints.
 - a. Control, expansion, and soft joints in masonry.
 - b. Joints between concrete and other materials.
 - c. Joints between metal frames and other materials.
 - d. Other exterior non-traffic bearing joints for which no other sealant is indicated.
- F. Urethane, M, NS, 25, T, NT: Multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type M, Grade NS, Class 25, Uses T and NT.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Bostik, Inc.; Chem-Calk 505.
 - b. LymTal International, Inc.; Iso-Flex 881.
 - c. Sika Corporation U.S.; Sikaflex - 2c NS EZ Mix.
- G. Traffic Joints Urethane, M, P, 25, T, NT: Multicomponent, pourable, self leveling, plus 25 percent and minus 25 percent movement capability, traffic use, urethane joint sealant; ASTM C 920, Type M, Grade P, Class 25, Uses T and 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. Pecora Corporation; Urexpan NR 200
 - b. Sherwin-Williams Company (The); Stampede-2SL.
 - c. Tremco Incorporated; THC 900/901.
 - d. BASF Building Systems; Sonneborn; Sonolastic SL2.
 2. Applications: Use for interior and exterior horizontal traffic bearing joints:
 - a. Joints in concrete floors and paving.
 - b. Soft joints in unit pavers.
 - c. Other traffic bearing joints for which no other sealant is indicated.

2.5 MILDEW-RESISTANT JOINT SEALANTS

- A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.

- B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.
1. 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; 898; Sanitary Mildew Resistant Silicone Sealant.
 - b. Dow Corning Corporation; 786-M White.
 - c. Momentive performance materials; GE Construction Sealants; SCS1700 Sanitary.
 - d. Tremco Incorporated; Tremsil 200.
 2. Applications: Use for kitchens, bathrooms, toilet rooms, lockers, and other wet areas:
 - a. Joints between plumbing fixtures and floor and wall surfaces.
 - b. Joints between kitchen and bath countertops and wall surfaces.
 - c. Joints between lockers and toilet accessories and adjacent surfaces.
 - d. Joints between sanitary wall panels and adjacent or penetrating materials.

2.6 LATEX JOINT SEALANTS

- A. Interior Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF. single component, nonstaining, nonbleeding, nonsagging.
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; AC-20.
 - b. Sherwin-Williams Company (The); 950A.
 - c. BASF Construction Chemicals, LLC, Building Systems; Sonolac.
 - d. Tremco Incorporated; Tremflex 834.
 2. Applications: Use for interior joints, except where sanitary sealant is required.
 - a. Interior wall and ceiling control joints.
 - b. Interior joints between door and window frames and wall surfaces.
 - c. Other interior joints for which no other type of sealant is indicated.

2.7 BUTYL JOINT SEALANTS

- A. Exterior Metal Lap Joint Sealant: ASTM C1311, butyl or polyisobutylene, nondrying, non-skinning, non-curing.
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; BC-98; Butyl Rubber Sealant.
 - b. Sherwin-Williams; White Lightning; Butyl Rubber Caulk.
 - c. Tremco, Inc.; Tremco Butyl Sealant.
 2. Applications: Concealed sealant bead in sheet metal and flashing work:

- a. Concealed sealant bead in sheet metal work.
- b. Concealed sealant bead in siding overlaps.
- c. Concealed sealant bead in vapor barrier.
- d. Concealed sealant bead in through wall flashing.
- e. Other concealed sealant joints where specified in other Sections.

2.8 POLYSULFIDE JOINT SEALANTS

- A. Polysulfide Sealant for Continuous Water Immersion: ASTM C920, Grade NS, Class 25, Uses NT, M, G, and A; suitable for continuous water immersion when tested in accordance with ASTM C1247; multi-component.
 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; Synthacalk GC2+.
 2. Applications: Use for joints in subject to constant water exposure.
 - a. Joints in fountain pool.
 - b. Aquarium joints.

2.9 ACOUSTICAL JOINT SEALANTS

- A. Interior Acoustic Sealant: Nonsag, paintable, nonstaining, butyl-free, latex sealant complying with ASTM C834 that effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E90. Furnish fire rated sealant for use in fire rated assemblies.
 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. Non-Fire Rated Sealants:
 - 1) Pecora Corp.; AIS-919.
 - 2) Tremco, Inc.; Tremflex 834.
 - b. Fire Rated Sealants:
 - 1) Pecora Corp.; AC-20 FTR Acoustical and Insulation Sealant.
 - 2) Tremco, Inc.; TremStop Acrylic.
 2. Applications: For use:
 - a. Through perimeter joints and openings in building construction.

2.10 PREFORMED JOINT SEALANTS

- A. Preformed Silicone Joint Sealants: Manufacturer's standard sealant consisting of precured low-modulus silicone extrusion, in sizes to fit joint widths indicated, combined with a neutral-curing silicone sealant for bonding extrusions to substrates.

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; 123 Silicone Seal.
 - b. Momentive performance Materials; GE Advanced Materials - Silicones; UltraSpan US1100.
 - c. May National Associates, Inc.; Bondaflex Silbridge 300.
 - d. Pecora Corporation; Sil-Span.
 - e. Sealex, Inc.; ImmerSeal.
 - B. Preformed Foam Joint Sealant: Manufacturer's standard preformed, precompressed, open-cell foam sealant manufactured from urethane foam with minimum density of 10 lb/cu. ft. and impregnated with a nondrying, water-repellent agent. Factory produce in precompressed sizes in roll or stick form to fit joint widths indicated; coated on one side with a pressure-sensitive adhesive and covered with protective wrapping.
 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. EMSEAL Joint Systems, Ltd.; Emseal 25V.
 - b. Sandell Manufacturing Co., Inc.; Polyseal.
 - c. Schul International, Inc.; Sealtite.
 - d. Schul International, Inc.; Polytite Standard.
 - e. Willseal USA, LLC; Willseal 600.
- 2.11 JOINT SEALANT BACKING
- A. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), Type O (open-cell material), or 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.
 - B. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer.
- 2.12 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.
 - 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.
 - 1. Remove laitance and form-release agents from concrete.
 - 2. 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.
- 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. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- B. 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.
- C. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.

2. Completely fill recesses in each joint configuration.
 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified 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.
- F. Installation of Preformed Silicone-Sealant System: Comply with the following requirements:
1. Apply masking tape to each side of joint, outside of area to be covered by sealant system.
 2. Apply silicone sealant to each side of joint to produce a bead of size complying with preformed silicone-sealant system manufacturer's written instructions and covering a bonding area of not less than 3/8 inch. Hold edge of sealant bead 1/4 inch inside masking tape.
 3. Within 10 minutes of sealant application, press silicone extrusion into sealant to wet extrusion and substrate. Use a roller to apply consistent pressure and ensure uniform contact between sealant and both extrusion and substrate.
 4. Complete installation of sealant system in horizontal joints before installing in vertical joints. Lap vertical joints over horizontal joints. At ends of joints, cut silicone extrusion with a razor knife.
- G. Installation of Preformed Foam Sealants: Install each length of sealant immediately after removing protective wrapping. Do not pull or stretch material. Produce seal continuity at ends, turns, and intersections of joints. For applications at low ambient temperatures, apply heat to sealant in compliance with sealant manufacturer's written instructions.
- H. Acoustical Sealant Installation: 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 of joint length for each kind of sealant and joint substrate.

- b. Perform 1 test for each 1000 feet 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.
- 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.

END OF SECTION 079200

SECTION 079500 - EXPANSION 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. Interior expansion control systems.
 - 2. Exterior wall expansion control systems.

1.3 ACTION SUBMITTALS

- A. Shop Drawings: For each expansion control system specified. Include plans, elevations, sections, details, splices, blockout requirement, attachments to other work, and line diagrams showing entire route of each expansion control system. Where expansion control systems change planes, provide isometric or clearly detailed drawing depicting how components interconnect.
- B. Samples for Initial Selection: For each type of expansion control system indicated.
 - 1. Include manufacturer's color charts showing the full range of colors and finishes available for each exposed metal and elastomeric seal material.
- C. Samples for Verification: For each type of expansion control system indicated, full width by 6 inches long in size.
- D. Product Schedule: Prepared by or under the supervision of the supplier. Include the following information in tabular form:
 - 1. Manufacturer and model number for each expansion control system.
 - 2. Expansion control system location cross-referenced to Drawings.
 - 3. Nominal joint width.
 - 4. Movement capability.
 - 5. Classification as thermal or seismic.
 - 6. Materials, colors, and finishes.
 - 7. Product options.
 - 8. Fire-resistance ratings.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each fire barrier provided as part of an expansion control system, for tests performed by a qualified testing agency.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. General: Provide expansion control systems of design, basic profile, materials, and operation indicated. Provide units with capability to accommodate variations in adjacent surfaces.
 - 1. Furnish units in longest practicable lengths to minimize field splicing. Install with hairline mitered corners where expansion control systems change direction or abut other materials.
 - 2. Include factory-fabricated closure materials and transition pieces, T-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous expansion control systems.
- B. Coordination: Coordinate installation of exterior wall expansion control systems with roof expansion control systems to ensure that wall transitions are watertight. Roof expansion joint assemblies are specified elsewhere.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance Ratings: Where indicated, provide expansion control systems with fire barriers identical to those of systems tested for fire resistance per UL 2079 or ASTM E 1966 by a testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1. Hose Stream Test: Wall-to-wall and wall-to-ceiling systems shall be subjected to hose stream testing.
- B. Seismic Performance: Expansion control systems shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."
 - 2. Component Importance Factor is 1.0.

2.3 INTERIOR EXPANSION CONTROL SYSTEMS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated or a comparable product by one of the following:
 - 1. Architectural Art Mfg., Inc.; Division of Pittcon Industries.
 - 2. Balco, Inc.
 - 3. Construction Specialties, Inc.
 - 4. JointMaster/InPro Corporation.
 - 5. MM Systems Corporation.

6. Nystrom, Inc.
- B. Source Limitations: Obtain expansion control systems from single source from single manufacturer.
- C. Floor-to-Floor:
 1. Basis-of-Design Product: EMSEAL; FS75 with EMSHIELD DFR.
 2. Design Criteria:
 - a. Nominal Joint Width: As indicated on Drawings.
 - b. Minimum Joint Width: As indicated on Drawings.
 - c. Maximum Joint Width: As indicated on Drawings.
 - d. Type of Movement: As indicated on Drawings.
 - e. Load Capacity: As indicated on Drawings.
 - f. Fire-Resistance Rating: Provide expansion control system and fire-barrier assembly with a rating not less than 1/2 hour.
 3. Type: Glide plate.
 - a. Cover-Plate Design: Serrated.
 - 1) Cover-Plate Recess Depth: As required to accommodate adjacent flooring.
 - b. Metal: Aluminum.
 - 1) Finish: Manufacturer's standard.
- D. Floor-to-Wall:
 1. Basis-of-Design Product: EMSEAL; FS75 with EMSHIELD DFR.
 2. Design Criteria:
 - a. Nominal Joint Width: As indicated on Drawings.
 - b. Minimum Joint Width: As indicated on Drawings.
 - c. Maximum Joint Width: As indicated on Drawings.
 - d. Type of Movement: As indicated on Drawings.
 - e. Load Capacity: As indicated on Drawings.
 - f. Fire-Resistance Rating: Provide expansion control system and fire-barrier assembly with a rating not less than 1/2 hour.
 3. Type: Glide plate.
 - a. Cover-Plate Design: Serrated.
 - 1) Cover-Plate Recess Depth: As required to accommodate adjacent flooring.
 - b. Metal: Aluminum.
 - 1) Finish: Manufacturer's standard.

E. Wall-to-Wall:

1. Basis-of-Design Product: EMSEAL; KF250.
2. Design Criteria:
 - a. Nominal Joint Width: As indicated on Drawings.
 - b. Minimum Joint Width: As indicated on Drawings.
 - c. Maximum Joint Width: As indicated on Drawings.
 - d. Type of Movement: As indicated on Drawings.
 - e. Fire-Resistance Rating: Provide expansion control system and fire-barrier assembly with a rating not less than that indicated.
3. Type: Snap-on cover.
 - a. Metal: Aluminum.
 - 1) Finish: Manufacturer's standard.

F. Wall Corner:

1. Basis-of-Design Product: EMSEAL; KF250.
2. Design Criteria:
 - a. Nominal Joint Width: As indicated on Drawings.
 - b. Minimum Joint Width: As indicated on Drawings.
 - c. Maximum Joint Width: As indicated on Drawings.
 - d. Type of Movement: As indicated on Drawings.
 - e. Fire-Resistance Rating: Provide expansion control system and fire-barrier assembly with a rating not less than that indicated.
3. Type: Snap-on cover.
 - a. Metal: Aluminum.
 - 1) Finish: Manufacturer's standard.

G. Wall-to-Ceiling:

1. Basis-of-Design Product: EMSEAL; KF250.
2. Design Criteria:
 - a. Nominal Joint Width: As indicated on Drawings.
 - b. Minimum Joint Width: As indicated on Drawings.
 - c. Maximum Joint Width: As indicated on Drawings.
 - d. Type of Movement: As indicated on Drawings.
 - e. Fire-Resistance Rating: Provide expansion control system and fire-barrier assembly with a rating not less than that indicated.
3. Type: Snap-on cover.

- a. Metal: Aluminum.
 - 1) Finish: Manufacturer's standard.
- H. Ceiling-to-Ceiling:
 - 1. Basis-of-Design Product: EMSEAL; KF250.
 - 2. Design Criteria:
 - a. Nominal Joint Width: As indicated on Drawings.
 - b. Minimum Joint Width: As indicated on Drawings.
 - c. Maximum Joint Width: As indicated on Drawings.
 - d. Type of Movement: As indicated on Drawings.
 - e. Fire-Resistance Rating: Provide expansion control system and fire-barrier assembly with a rating not less than that indicated.
 - 3. Type: Snap-on cover.
 - a. Metal: Aluminum.
 - 1) Finish: Manufacturer's standard.

2.4 EXTERIOR WALL EXPANSION CONTROL SYSTEMS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated or a comparable product by one of the following:
 - 1. Architectural Art Mfg., Inc.; Division of Pittcon Industries.
 - 2. Balco, Inc.
 - 3. Construction Specialties, Inc.
 - 4. JointMaster/InPro Corporation.
 - 5. MM Systems Corporation.
 - 6. Nystrom, Inc.
 - 7. Schul International Company, Inc.
 - 8. Tremco Incorporated.
 - 9. Williams Products, Inc.
- B. Source Limitations: Obtain expansion control systems from single source from single manufacturer.
- C. Wall-to-Wall:
 - 1. Basis-of-Design Product: EMSEAL; Seismic Colorseal.
 - 2. Design Criteria:
 - a. Nominal Joint Width: As indicated on Drawings.
 - b. Minimum Joint Width: As indicated on Drawings.
 - c. Maximum Joint Width: As indicated on Drawings.

- d. Type of Movement: Seismic.
- 3. Type: Preformed cellular foam.
 - a. Foam Material: Manufacturer's standard.
 - 1) Color: As selected by Architect from manufacturer's full range.
- D. Wall Corner:
 - 1. Basis-of-Design Product: EMSEAL; Seismic Colorseal.
 - 2. Design Criteria:
 - a. Nominal Joint Width: As indicated on Drawings.
 - b. Minimum Joint Width: As indicated on Drawings.
 - c. Maximum Joint Width: As indicated on Drawings.
 - d. Type of Movement: Seismic.
 - 3. Type: Preformed cellular foam.
 - a. Foam Material: Manufacturer's standard.
 - 1) Color: As selected by Architect from manufacturer's full range.

2.5 MATERIALS

- A. Aluminum: ASTM B 221, Alloy 6063-T5 for extrusions; ASTM B 209, Alloy 6061-T6 for sheet and plate.
 - 1. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.
- B. Cellular Foam Seals: Extruded, compressible foam designed to function under compression.
- C. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist the passage of flame and hot gases through a movement joint and to meet performance criteria for required fire-resistance rating.
- D. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.
- E. Accessories: Manufacturer's standard anchors, clips, fasteners, set screws, spacers, and other accessories compatible with material in contact, as indicated or required for complete installations.

2.6 GENERAL FINISH REQUIREMENTS

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

- C. 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.

2.7 ALUMINUM FINISHES

- A. Mill finish.
- B. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces where expansion control systems will be installed for installation tolerances and other conditions affecting performance of work.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to expansion control system manufacturer's written instructions.
- B. Coordinate and furnish anchorages, setting drawings, and instructions for installing expansion control systems. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of expansion control systems.
- C. Cast-In Frames: Coordinate and furnish frames to be cast into concrete.

3.3 INSTALLATION

- A. Comply with manufacturer's written instructions for storing, handling, and installing expansion control systems and materials unless more stringent requirements are indicated.
- B. Metal Frames: Perform cutting, drilling, and fitting required to install expansion control systems.
 - 1. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
 - 2. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation. Notify Architect where discrepancies occur that will affect proper expansion control system installation and performance.
 - 3. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.
 - 4. Repair or grout blockout as required for continuous frame support using nonmetallic, shrinkage-resistant grout.

5. Install frames in continuous contact with adjacent surfaces.
 - a. Shimming is not permitted.
 6. Locate anchors at interval recommended by manufacturer, but not less than 3 inches from each end and not more than 24 inches o.c.
- C. Foam Seals: Install with adhesive recommended by manufacturer.
- D. Terminate exposed ends of expansion control systems with field- or factory-fabricated termination devices.
- E. Fire-Resistance-Rated Assemblies: Coordinate installation of expansion control system materials and associated work so complete assemblies comply with assembly performance requirements.
1. Fire Barriers: Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of joint, including transitions and field splices.

3.4 PROTECTION

- A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.
- B. Protect the installation from damage by work of other Sections. Where necessary due to heavy construction traffic, remove and properly store cover plates or seals and install temporary protection over expansion control systems. Reinstall cover plates or seals prior to Substantial Completion of the Work.

END OF SECTION 079500

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Standard and custom hollow metal doors and frames.
2. Steel sidelight, borrowed lite and transom frames.
3. Louvers installed in hollow metal doors.
4. Light frames and glazing installed in hollow metal doors.

B. Related Sections:

1. Division 01 Section "General Conditions".
2. Division 04 Section "Unit Masonry" for embedding anchors for hollow metal work into masonry construction.
3. Division 08 Section "Flush Wood Doors".
4. Division 08 Section "Glazing" for glass view panels in hollow metal doors.
5. Division 08 Section "Door Hardware".
6. Division 08 Section "Access Control Hardware".
7. Division 09 Sections "Exterior Painting" and "Interior Painting" for field painting hollow metal doors and frames.

C. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI/SDI A250.8 - Recommended Specifications for Standard Steel Doors and Frames.
2. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames, Frames Anchors and Hardware Reinforcing.
3. ANSI/SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames.
4. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
5. ANSI/SDI A250.11 - Recommended Erection Instructions for Steel Frames.
6. ASTM A1008 - Standard Specification for Steel Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

7. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
8. ASTM A924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
9. ASTM C 1363 - Standard Test Method for Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus.
10. ANSI/BHMA A156.115 - Hardware Preparation in Steel Doors and Frames.
11. ANSI/SDI 122 - Installation and Troubleshooting Guide for Standard Steel Doors and Frames.
12. ANSI/NFPA 80 - Standard for Fire Doors and Fire Windows; National Fire Protection Association.
13. ANSI/NFPA 105: Standard for the Installation of Smoke Door Assemblies.
14. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; National Fire Protection Association.
15. UL 10C - Positive Pressure Fire Tests of Door Assemblies.
16. UL 1784 - Standard for Air Leakage Tests of Door Assemblies.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, hardware reinforcements, profiles, anchors, fire-resistance rating, and finishes.
- B. Door hardware supplier is to furnish templates, template reference number and/or physical hardware to the steel door and frame supplier in order to prepare the doors and frames to receive the finish hardware items.
- C. Shop Drawings: Include the following:
 1. Elevations of each door design.
 2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
 4. Locations of reinforcement and preparations for hardware.
 5. Details of anchorages, joints, field splices, and connections.
 6. Details of accessories.
 7. Details of moldings, removable stops, and glazing.
 8. Details of conduit and preparations for power, signal, and control systems.
- D. Samples for Verification:
 1. Samples are only required by request of the architect and for manufacturers that are not current members of the Steel Door Institute.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain hollow metal doors and frames through one source from a single manufacturer wherever possible.

- B. Quality Standard: In addition to requirements specified, furnish SDI-Certified manufacturer products that comply with ANSI/SDI A250.8, latest edition, "Recommended Specifications for Standard Steel Doors and Frames".
- C. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to UL10C (neutral pressure at 40" above sill) or UL 10C.
 - 1. Oversize Fire-Rated Door Assemblies Construction: For units exceeding sizes of tested assemblies, attach construction label certifying doors are built to standard construction requirements for tested and labeled fire rated door assemblies except for size.
 - 2. Temperature-Rise Limit: Where indicated and at vertical exit enclosures (stairwell openings) and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.
 - 3. Smoke Control Door Assemblies: Comply with NFPA 105.
 - a. Smoke "S" Label: Doors to bear "S" label, and include smoke and draft control gasketing applied to frame and on meeting stiles of pair doors.
- D. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257. Provide labeled glazing material.
- E. Pre-Submittal Conference: Conduct conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier, Installer, and Contractor to review proper methods and procedures for installing hollow metal doors and frames and to verify installation of electrical knockout boxes and conduit at frames with electrified or access control hardware.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project site storage. Do not use non-vented plastic.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch high wood blocking. Do not store in a manner that traps excess humidity.
 - 1. Provide minimum 1/4-inch space between each stacked door to permit air circulation. Door and frames to be stacked in a vertical upright position.

1.6 PROJECT CONDITIONS

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

1.7 COORDINATION

- A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.
- B. Building Information Modeling (BIM) Support: Utilize designated BIM software tools and obtain training needed to successfully participate in the Project BIM processes. All technical disciplines are responsible for the product data integration and data reliability of their Work into the coordinated BIM applications.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
- B. Warranty includes installation and finishing that may be required due to repair or replacement of defective doors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide steel doors and frames from a SDI Certified manufacturer:
 - 1. CECO Door Products (C).
 - 2. Curries Company (CU).
 - 3. Pioneer Industries (PI).
 - 4. Steelcraft (S)

2.2 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.
- C. Frame Anchors: ASTM A 653/A 653M, Commercial Steel (CS), Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

2.3 HOLLOW METAL DOORS

- A. General: Provide 1-3/4 inch doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8 and ANSI/NAAMM HMMA 867.
- B. Exterior Doors (Energy Efficient): Face sheets fabricated of commercial quality hot-dipped zinc coated steel that complies with ASTM A924 A60. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model, ANSI/SDI A250.4 for physical performance level, and HMMA 867 for door construction.
 - 1. Design: Flush panel.
 - 2. Core Construction: Foamed in place polyurethane and steel stiffened laminated core with no stiffener face welds, in compliance with HMMA 867 "Laminated Core".
 - a. Provide 22 gauge steel stiffeners at 6 inches on-center internally welded at 5" on-center to integral core assembly, foamed in place polyurethane core chemically bonded to all interior surfaces. No stiffener face welding is permitted.
 - b. Thermal properties to rate at a fully operable minimum U-Factor 0.37 and R-Value 2.7, including insulated door, thermal-break frame and threshold.
 - c. Kerf Type Frames: Thermal properties to rate at a fully operable minimum U-Factor 0.38 and R-Value 2.6, including insulated door, kerf type frame, and threshold.
 - 3. Level/Model: Level 3 and Physical Performance Level A (Extra Heavy Duty), Minimum 16 gauge (0.053 inch - 1.3-mm) thick steel, Model 2.
 - 4. Vertical Edges: Vertical edges to be mechanically interlocked with hairline seam. Beveled Lock Edge, 1/8 inch in 2 inches (3 mm in 50 mm).
 - 5. Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 16 gauge, extending the full width of the door and welded to the face sheet. Doors with an inverted top channel to include a steel closure channel, screw attached, with the web of the channel flush with the face sheets of the door. Plastic or composite channel fillers are not acceptable.
 - 6. Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9".
 - 7. Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.
- C. Interior Doors: Face sheets fabricated of commercial quality cold rolled steel that complies with ASTM A 1008/A 1008M. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
 - 1. Design: Flush panel.
 - a. Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.

2. Level/Model: Level 2 and Physical Performance Level B (Heavy Duty), Minimum 18 gauge (0.042-inch - 1.0-mm) thick steel, Model 2.
3. Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 16 gauge, extending the full width of the door and welded to the face sheet.
4. Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9" or minimum 14 gauge continuous channel with pierced holes, drilled and tapped.
5. Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

D. Manufacturers Basis of Design:

1. Curries Company (CU) - Polystyrene Core - 707 Series.
2. Curries Company (CU) - Energy Efficient - 777 Trio-E Series.

2.4 HOLLOW METAL FRAMES

- A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.
- B. Thermal Break Frames: Subject to the same compliance standards and requirements as standard hollow metal frames. Tested for thermal performance in accordance with NFRC 102, and resistance to air infiltration in accordance with NFRC 400. Where indicated provide thermally broken frame profiles available for use in both masonry and drywall construction. Fabricate with 1/16" positive thermal break and integral vinyl weatherstripping.
- C. Exterior Frames: Fabricated of hot-dipped zinc coated steel that complies with ASTM A 653/A 653M, Coating Designation A60.
 1. Fabricate frames with mitered or coped corners. Profile as indicated on drawings.
 2. Frames: Minimum 14 gauge (0.067-inch -1.7-mm) thick steel sheet.
 3. Manufacturers Basis of Design:
 - a. Curries Company (CU) – Thermal Break TQ Series.
- D. Interior Frames: Fabricated from cold-rolled steel sheet that complies with ASTM A 1008/A 1008M.
 1. Fabricate frames with mitered or coped corners. Profile as indicated on drawings.
 2. Frames: Minimum 16 gauge (0.053-inch -1.3-mm) thick steel sheet.
 3. Manufacturers Basis of Design:
 - a. Curries Company (CU) - M Series.
- E. Fire rated frames: Fabricate frames in accordance with NFPA 80, listed and labeled by a qualified testing agency, for fire-protection ratings indicated.
- F. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 Table 4 with reinforcement plates from same material as frames.

2.5 FRAME ANCHORS

- A. Jamb Anchors:
 - 1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, formed from A60 metallic coated material, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
 - 2. Stud Wall Type: Designed to engage stud and not less than 0.042 inch thick.
- B. Floor Anchors: Floor anchors to be provided at each jamb, formed from A60 metallic coated material, not less than 0.042 inches thick.
- C. Mortar Guards: Formed from same material as frames, not less than 0.016 inches thick.

2.6 LOUVERS

- A. Metal Louvers: Unless otherwise indicated provide louvers to meet the following requirements.
 - 1. Blade Type: Vision proof inverted V or inverted Y.
 - 2. Metal and Finish: Galvanized steel, 0.040 inch thick, factory primed for paint finish with baked enamel or powder coated finish. Match pre-finished door paint color where applicable.
- B. Louvers for Fire Rated Doors: Metal louvers with fusible link and closing device, listed and labeled for use in doors with fire protection rating of 1-1/2 hours and less.
 - 1. Manufacturers: Subject to compliance with requirements, provide louvers to meet rating indicated.
 - 2. Metal and Finish: Galvanized steel, 0.040 inch thick, factory primed for paint finish with baked enamel or powder coated finish. Match pre-finished door paint color where applicable.

2.7 LIGHT OPENINGS AND GLAZING

- A. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints at fabricator's shop. Fixed and removable stops to allow multiple glazed lites each to be removed independently. Coordinate frame rabbet widths between fixed and removable stops with the type of glazing and installation indicated.
- B. Moldings for Glazed Lites in Doors and Loose Stops for Glazed Lites in Frames: Minimum 20 gauge thick, fabricated from same material as door face sheet in which they are installed.
- C. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch (16 mm) high unless otherwise indicated. Provide fixed frame moldings and stops on outside of exterior and on secure side of interior doors and frames.

- D. Preformed Metal Frames for Light Openings: Manufacturer's standard frame formed of 0.048-inch-thick, cold rolled steel sheet; with baked enamel or powder coated finish; and approved for use in doors of fire protection rating indicated. Match pre-finished door paint color where applicable.

2.8 ACCESSORIES

- A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.
- B. Grout Guards: Formed from same material as frames, not less than 0.016 inches thick.

2.9 FABRICATION

- A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. When shipping limitations so dictate, frames for large openings are to be fabricated in sections for splicing or splining in the field by others.
- B. Tolerances: Fabricate hollow metal work to tolerances indicated in ANSI/SDI A250.8.
- C. Hollow Metal Doors:
 - 1. Exterior Doors: Provide optional weep-hole openings in bottom of exterior doors to permit moisture to escape where specified.
 - 2. Glazed Lites: Factory cut openings in doors with applied trim or kits to fit. Factory install glazing where indicated.
 - 3. Astragals: Provide overlapping astragals as noted in door hardware sets in Division 08 Section "Door Hardware" 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.
 - 4. Continuous Hinge Reinforcement: Provide welded continuous 12 gauge strap for continuous hinges specified in hardware sets in Division 08 Section "Door Hardware".
- D. Hollow Metal Frames:
 - 1. Shipping Limitations: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
 - 2. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
 - a. Welded frames are to be provided with two steel spreaders temporarily attached to the bottom of both jambs to serve as a brace during shipping and handling. Spreader bars are for bracing only and are not to be used to size the frame opening.

3. Sidelight 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 butt welding.
 4. High Frequency Hinge Reinforcement: Provide high frequency hinge reinforcements at door openings 48-inches and wider with mortise butt type hinges at top hinge locations.
 5. Continuous Hinge Reinforcement: Provide welded continuous 12 gauge straps for continuous hinges specified in hardware sets in Division 08 Section "Door Hardware".
 6. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated for removable stops, provide security screws at exterior locations.
 7. Mortar Guards: Provide guard boxes at back of hardware mortises in frames at all hinges and strike preps regardless of grouting requirements.
 8. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
 9. Jamb Anchors: Provide number and spacing of anchors as follows:
 - a. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
 - 1) Two anchors per jamb up to 60 inches high.
 - 2) Three anchors per jamb from 60 to 90 inches high.
 - 3) Four anchors per jamb from 90 to 120 inches high.
 - 4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.
 - b. Stud Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
 - 1) Three anchors per jamb up to 60 inches high.
 - 2) Four anchors per jamb from 60 to 90 inches high.
 - 3) Five anchors per jamb from 90 to 96 inches high.
 - 4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
 - 5) Two anchors per head for frames above 42 inches wide and mounted in metal stud partitions.
 10. Door Silencers: Except on weatherstripped or gasketed doors, drill stops to receive door silencers. Silencers to be supplied by frame manufacturer regardless if specified in Division 08 Section "Door Hardware".
 11. Bituminous Coating: Where frames are fully grouted with an approved Portland Cement based grout or mortar, coat inside of frame throat with a water based bituminous or asphaltic emulsion coating to a minimum thickness of 3 mils DFT, tested in accordance with UL 10C and applied to the frame under a 3rd party independent follow-up service procedure.
- E. Hardware Preparation: Factory prepare hollow metal work to receive template mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to

the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."

1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
2. Reinforce doors and frames to receive non-template, mortised and surface mounted door hardware.
3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections.

2.10 STEEL FINISHES

- A. Prime Finishes: Doors and frames to be cleaned, and chemically treated to insure maximum finish paint adhesion. Surfaces of the door and frame exposed to view to receive a factory applied coat of rust inhibiting shop primer.
 1. Shop Primer: Manufacturer's standard, fast-curing, lead and chromate free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; and compatible with substrate and field-applied coatings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. General Contractor to verify the accuracy of dimensions given to the steel door and frame manufacturer for existing openings or existing frames (strike height, hinge spacing, hinge back set, etc.).
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove welded in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
- B. Prior to installation, adjust and securely brace welded hollow metal frames for square, level, twist, and plumb condition.
- C. Tolerances shall comply with SDI-117 "Manufacturing Tolerances Standard Steel Doors and Frames."

- D. Drill and tap doors and frames to receive non-template, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

- A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.
- B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11 and NFPA 80 at fire rated openings.
 - 1. Set frames accurately in position, plumbed, leveled, aligned, and braced securely until permanent anchors are set. After wall construction is complete and frames properly set and secured, remove temporary braces, leaving surfaces smooth and undamaged. Shim as necessary to comply with installation tolerances.
 - 2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.
 - 3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with mortar.
 - 4. Grout Requirements: Do not grout head of frames unless reinforcing has been installed in head of frame. Do not grout vertical or horizontal closed mullion members.
- C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
 - 1. Non-Fire-Rated Standard Steel Doors:
 - a. Jambs and Head: 1/8 inch plus or minus 1/16 inch.
 - b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
 - c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
 - d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.
 - 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
- D. Field Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with hollow metal manufacturer's written instructions.

3.4 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.
- B. Remove grout and other bonding material from hollow metal work immediately after installation.

- C. Prime-Coat and Painted Finish Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat, or painted finishes, and apply touchup of compatible air drying, rust-inhibitive primer, zinc rich primer (exterior and galvanized openings) or finish paint.

3.5 FIELD QUALITY CONTROL

- A. Field Inspection (Punch Report): Reference Division 01 Sections "Closeout Procedures". Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.
 - 1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.

END OF SECTION 081113

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 fitting flush wood doors to frames and factory machining for hardware.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of door indicated. Include details of core and edge construction, louvers, and trim for openings.
- B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; and the following:
 - 1. Dimensions and locations of blocking.
 - 2. Dimensions and locations of mortises and holes for hardware.
 - 3. Dimensions and locations of cutouts.
 - 4. Undercuts.
 - 5. Requirements for veneer matching.
 - 6. Doors to be factory finished and finish requirements.
 - 7. Fire-protection ratings for fire-rated doors.
- C. Samples for Initial Selection: For factory-finished doors.
- D. Samples for Verification:
 - 1. 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.
2. 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 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 top or bottom rail with opening number used on Shop Drawings.

1.7 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 between 60 and 90 deg F and relative humidity between 25 and 55 percent during the remainder of the construction period.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
 - b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
 2. Warranty Period for Solid-Core Interior Doors: Life of installation.

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. Eggers Industries.
 - 2. VT Industries Inc.
- B. Source Limitations: Obtain flush wood doors from single manufacturer.

2.2 FLUSH WOOD DOORS, GENERAL

- A. WDMA I.S.1-A Performance Grade: Heavy Duty.
- B. Structural-Composite-Lumber-Core Doors:
 - 1. Structural Composite Lumber: WDMA I.S.10.
 - a. Screw Withdrawal, Face: 700 lbf.
 - b. Screw Withdrawal, Edge: 400 lbf.
- C. Fire-Protection-Rated Doors: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
 - 1. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
 - 2. Pairs: Provide formed-steel edges and astragals.
 - a. Finish steel edges and astragals to match door hardware (locksets or exit devices).
- D. 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.
 - a. 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.
 - 2. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.

2.3 VENEER-FACED DOORS FOR TRANSPARENT FINISH

- A. Interior Solid-Core Doors:

1. Grade: Premium (Grade A faces).
2. Species: White Birch
3. Cut: Plain sliced (flat sliced).
4. Match between Veneer Leaves: Book match.
5. Assembly of Veneer Leaves on Door Faces: Running match.
6. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
7. Room Match: Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by 20 feet or more.
8. Exposed Vertical and Top Edges: Same species as faces or a compatible species - edge Type A.
9. Core: Structural composite lumber.
10. Construction: Five or seven plies. Stiles and rails are bonded to core, then entire unit is abrasive planed before veneering.
11. WDMA I.S.1-A Performance Grade: Heavy Duty.

2.4 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
 1. Comply with requirements in NFPA 80 for fire-rated doors.
- B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.
 1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
 2. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.
- C. Openings: 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."

2.5 FACTORY FINISHING

- A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
 1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on bottom edges, edges of cutouts, and mortises.

- B. Factory finish doors that are indicated to receive transparent finish.
- C. Transparent Finish:
 - 1. Grade: Custom.
 - 2. Finish: AWI's, AWMAC's, and WI's "Architectural Woodwork Standards" System 11, catalyzed polyurethane, or WDMA TR-6 catalyzed polyurethane.
 - 3. Staining: Custom to match Wilsonart Fusion Maple Plastic Laminate.
 - 4. Sheen: Satin unless indicated otherwise.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Hardware: For installation, see Section 087100 "Door Hardware."
- B. Installation Instructions: Install doors to comply with manufacturer's written instructions and the referenced quality standard, and as indicated.
 - 1. Install fire-rated doors according to NFPA 80.
- C. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
- D. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.
- E. Provide matching finish wood veneer for astragal locations at door pairs.

3.3 ADJUSTING

- A. Operation: Rehang or replace doors that do not swing or operate freely.
- B. Finished Doors: Replace doors that are damaged or 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 081416

SECTION 081613 - FRP FLUSH 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. Fiberglass reinforced polyester (FRP) flush doors with aluminum frames.

1.3 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's product data, including description of materials, components, fabrication, finishes, and installation.
- B. Shop Drawings: Submit manufacturer's shop drawings, including elevations, sections, and details, indicating dimensions, tolerances, materials, fabrication, doors, panels, framing, hardware schedule, and finish.
- C. Samples:
 - 1. Door: Submit manufacturer's sample of door showing face sheets, core, framing, and finish.
 - 2. Color: Submit manufacturer's samples of standard colors of doors and frames.
- D. Test Reports: Submit certified test reports from qualified independent testing agency indicating doors comply with specified performance requirements.
- E. Manufacturer's Project References: Submit list of successfully completed projects including project name and location, name of architect, and type and quantity of doors manufactured.
- F. Maintenance Manual: Submit manufacturer's maintenance and cleaning instructions for doors, including maintenance and operating instructions for hardware.
- G. Warranty: Submit manufacturer's standard warranty.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Continuously engaged in manufacturing of doors of similar type to that specified, with a minimum of 25 years successful experience.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying opening door mark and manufacturer.
- B. Storage: Store materials in clean, dry area indoors in accordance with manufacturer's instructions.
- C. Handling: Protect materials and finish from damage during handling and installation.

1.6 WARRANTY

- A. Warrant doors, frames, and factory hardware against failure in materials and workmanship, including excessive deflection, faulty operation, defects in hardware installation, and deterioration of finish or construction in excess of normal weathering.
- B. Warranty Period: Ten years starting on date of shipment.

PART 2 - PRODUCTS

2.1 FLUSH TYPE EXTERIOR FRP DOORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Cline Doors; Series 500 SE stile and rail doors, or comparable product by one of the following:
 - 1. Architectural Doors Inc.
 - 2. Special-Lite.
- B. Test Reports and Performance Requirements:
 - 1. Door Leaf Requirement Tests: Door leaf without frame or hardware and with a minimum lite cut out of 12 inches by 24 inches is to meet the following criteria:
 - a. Concentrated Load Bow Test: 4200 lbs. minimum load with no permanent deflection to door leaf.
 - b. Torsion Twist Test: @300 lbs. minimum load with no permanent set to door leaf.
 - 2. Face Sheet Requirement Tests: FRP material and FRP face sheets with core material are to meet the following criteria:

- a. Center Door Section (face sheet/core/face sheet):
 - 1) Gardner Impact Test - ASTM D5420 – 411.84 in-lb.
- b. FRP Material (MR85):
 - 1) Flexural Strength Test:
 - a) ASTM D790 - 22,680 psi (inward).
 - b) 24,400 psi (outward).
 - 2) Izod Impact Strength Test:
 - a) ASTM D256 - 15.36 ft-lb./in thickness.
 - 3) Barcol Hardness - ASTM D5420 – 50.

C. Materials:

1. Aluminum Members:

- a. Doors, frames, miscellaneous components, and entrance systems accessories are to be from the same manufacturer. Splitting the source for these items will not be permitted.
- b. Provide alloy and temper as recommended for resistance to corrosion and color control. Aluminum member references are ASTM B 221 for extrusions and ASTM B 209 for sheets.

2. Aluminum Edged Fiberglass (FRP) Panels:

- a. Construction: Panels will be constructed of two sheets of 0.120 fiberglass sheets bonded to 3/4-inch core material. Panel thickness will be 1-inch. An aluminum frame surrounds the perimeter of the panel, and measures 1 inch by 1 inch by 1 inch with 1/8-inch wall thickness.
- b. Wood edged panels will not be accepted.
- c. Core material will be 25-psi density polystyrene with a flame spread rating higher than 25 requiring an aluminum liner between the FRP face sheet and the urethane core material. Core material must have a proven record for use in panel fabrication without delaminating. Urethane core panels will require a letter from the manufacturer offering special guarantee that the FRP face sheets will not delaminate (bubble) for a period of 10 years, and that the manufacturer will cover all replacement costs if delamination does occur.
- d. FRP face sheets will be 0.120 minimum thickness with a pebble like surface.
- e. FRP face sheets are MR85 high impact frp material that has been tested by ASTM D5420 Gardner Impact Test with "Mean Failure Energy" rating no lower than 411.84 in-lb.
- f. Color will be selected from CDS color chart.

3. Extra Heavy Duty Fiberglass Wide Stile (FRP) Doors:

- a. Structural Main Frame: Doors have an aluminum main frame constructed from extruded aluminum 6063 -T6 alloy. Doors are 1-3/4 inch thick. Main frame tube is to be a single extruded unit measuring 1-1/2 inches by 5-1/2 inches (O.D.) on both side stiles, and 6-inches (O.D.) Top and Bottom rails. Spliced extrusions that are joined together to measure 6 inches will not be accepted.
 - b. Main Frame Wall Thickness:
 - 1) Side Stiles: Minimum 3/16 inch thick hinge edge wall.
 - 2) Top and Bottom Rails: Minimum 1/8 inch thick outside edge wall. (tie rod spline built into tube)
 - 3) All Rails and Stiles: Minimum 1/8 inch thick face walls.
 - 4) All Rails and Stiles: Minimum 1/8 inch thick inside edge wall.
 - c. Main Frame Joinery: Assembly for the meeting joints of the Rails and Stiles on the main frame are to be mortise & tenon on all four joints:
 - 1) Secured with:
 - a) 2 Tie Rods in Head Rail
 - b) 1 Tie Rod in Bottom Rail
 - d. Welded joints will not be accepted.
4. Inter-Loc Edge Trim: All aluminum trim is completely removable. All parts of the door are replaceable and repairable in the field. No fastening devices are exposed on the Stile Edge Trims.
- a. Snap-on or screw-on stile trim will not be accepted.
5. Weatherstripping: Center stiles of pairs will have pile weather-stripping 0.500 backing width, 0.5 inch pile height.
6. Hardware Reinforcing: Closer reinforcing to be 3/16 inch steel inserted into head rail. Other surface applied hardware is reinforced with the standard main frame tube wall thickness of 1/8 inch. Reinforcing for mortise and concealed hardware is to be done per template requirements.
- a. Hex or thru bolts will not be accepted.
 - b. Flush mounted door pulls must be provided as part of hardware requirement.
7. Wide Stile FRP doors will carry a 25 year limited warranty on doors structural integrity, main frame, and the lamination between face sheets and core. Warrantees are to be in writing from the door manufacturer.

2.2 ALUMINUM FINISHES

A. Anodized Finish: Class I finish, 0.7 mils thick.

- 1. Clear Anodized, AA-M10C21A44/AA-M45C22A44, Class I, 0.7 mils thick.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive doors. Notify Architect of conditions that would adversely affect installation or subsequent use. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 PREPARATION

- A. Ensure openings to receive frames are plumb, level, square, and in tolerance.

3.3 INSTALLATION

- A. Install doors in accordance with manufacturer's instructions.
- B. Install doors plumb, level, square, true to line, and without warp or rack.
- C. Anchor frames securely in place.
- D. Separate aluminum from other metal surfaces with bituminous coatings or other means approved by Architect.
- E. Set thresholds in bed of mastic and backseal.
- F. Install exterior doors to be weathertight in closed position.
- G. Repair minor damages to finish in accordance with manufacturer's instructions and as approved by Architect.
- H. Remove and replace damaged components that cannot be successfully repaired as determined by Architect.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Manufacturer's representative shall provide technical assistance and guidance for installation of doors.

3.5 ADJUSTING

- A. Adjust doors, hinges, and locksets for smooth operation without binding.

3.6 CLEANING

- A. Clean doors promptly after installation in accordance with manufacturer's instructions.
- B. Do not use harsh cleaning materials or methods that would damage finish.

3.7 PROTECTION

- A. Protect installed doors to ensure that, except for normal weathering, doors will be without damage or deterioration at time of substantial completion.

END OF SECTION 081613

SECTION 083113 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Access doors and frames for walls and ceilings.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, fire ratings, materials, individual components and profiles, and finishes.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Detail fabrication and installation of access doors and frames for each type of substrate.
- C. Samples: For each door face material, at least 3 by 5 inches in size, in specified finish.
- D. Product Schedule: Provide complete access door and frame schedule, including types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Access Doors and Frames: Units complying with NFPA80 that are identical to access door and frame assemblies tested for fire-test-response characteristics

according to the following test method and that are listed and labeled by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. NFPA 252 or UL10B for fire-rated access door assemblies installed vertically.

2.2 STEEL MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
 1. ASTM A123/A123M, for galvanizing steel and iron products.
 2. ASTM A153/A153M, for galvanizing steel and iron hardware.
- B. Steel Sheet: Uncoated or electrolytic zinc-coated, ASTM A591/A591M with cold-rolled steel sheet substrate complying with ASTM A1008/A1008M, Commercial Steel (CS), exposed.
- C. Drywall Beads: Edge trim formed from 0.0299-inch zinc-coated steel sheet formed to receive joint compound and in size to suit thickness of gypsum board.

2.3 ACCESS DOORS AND FRAMES

- 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. Babcock-Davis.
 2. J. L. Industries, Inc.
 3. Karp Associates, Inc.
 4. Larsen's Manufacturing Company.
 5. Milcor Inc.
 6. Nystrom, Inc.
- B. Source Limitations: Obtain each type of access door and frame from single source from single manufacturer.
- C. Flush Access Doors with Exposed Flanges:
 1. Assembly Description: Fabricate door to fit flush to frame. Provide manufacturer's standard-width exposed flange, proportional to door size.
 2. Locations: Wall and ceiling.
 3. Door Size: As indicated.
 4. Uncoated Steel Sheet for Door: Nominal 0.060 inch, 16 gage.
 - a. Finish: Factory prime.
 5. Frame Material: Same material, thickness, and finish as door.
 6. Hinges: Manufacturer's standard.

7. Hardware: Lock.

D. Flush Access Doors with Concealed Flanges:

1. Assembly Description: Fabricate door to fit flush to frame. Provide frame with gypsum board beads for concealed flange installation.
2. Locations: Wall and ceiling.
3. Door Size: As indicated.
4. Uncoated Steel Sheet for Door: Nominal 0.060 inch, 16 gage.
 - a. Finish: Factory prime.
5. Frame Material: Same material and thickness as door.
6. Hinges: Manufacturer's standard.
7. Hardware: Lock.

E. Fire-Rated, Flush Access Doors with Exposed Flanges:

1. Assembly Description: Fabricate door to fit flush to frame, with a core of mineral-fiber insulation enclosed in sheet metal. Provide self-latching door with automatic closer and interior latch release. Provide manufacturer's standard-width exposed flange, proportional to door size.
2. Locations: Wall and ceiling.
3. Fire-Resistance Rating: Not less than that of adjacent construction.
4. Uncoated Steel Sheet for Door: Nominal 0.036 inch, 20 gage.
 - a. Finish: Factory prime.
5. Frame Material: Nominal 0.060 inch, 16 gage, same material and finish as door.
6. Hinges: Manufacturer's standard.
7. Hardware: Lock.

F. Fire-Rated, Flush Access Doors with Concealed Flanges:

1. Assembly Description: Fabricate door to fit flush to frame, with a core of mineral-fiber insulation enclosed in sheet metal. Provide self-latching door with automatic closer and interior latch release. Provide frame with gypsum board beads for concealed flange installation.
2. Locations: Wall and ceiling.
3. Fire-Resistance Rating: Not less than that of adjacent construction.
4. Uncoated Steel Sheet for Door: Nominal 0.036 inch, 20 gage.
 - a. Finish: Factory prime.
5. Frame Material: Nominal 0.060 inch, 16 gage, same material and finish as door.
6. Hinges: Manufacturer's standard.
7. Hardware: Lock.

G. Hardware:

1. Latch: Cam latch operated by screwdriver.
2. Lock: Cylinder.

a. Lock Preparation: Prepare door panel to accept cylinder specified in Section 087100 "Door Hardware."

- H. Hardware: Stainless steel hinges with removable pin, screw driver slot with quarter turn cam lock, except for fire rated access doors.

2.4 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A879/A879M, with cold-rolled steel sheet substrate complying with ASTM A1008/A1008M, Commercial Steel (CS), exposed.
- C. Frame Anchors: Same type as door face.
- D. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329.

2.5 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of supports indicated.
1. For trimless frames with drywall bead, provide edge trim for gypsum board and gypsum base securely attached to perimeter of frames.
 2. Provide mounting holes in frames for attachment of units to metal or wood framing.
 3. Provide mounting holes in frame for attachment of masonry anchors. Furnish adjustable metal masonry anchors.
- D. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.
1. For cylinder lock, furnish two keys per lock and key all locks alike.

2.6 ACCESS DOOR SIZE

- A. Minimum Size: 24-inch by 32-inch for any items to be accessed requiring shoulders to fit through access door opening.
- B. Provide 32-inch by 40-inch doors in 6-inch thick or thicker block or stud walls.
- C. Provide 16-inch by 16-inch doors at locations where item to be accessed is entirely accessible and convenient to work on within 8-inches of access door face of wall or ceiling.
- D. Where access doors are required to accommodate filters or similar replacement/maintenance equipment, doors shall be of size to pass 1.25 percent of the least equipment dimension.
- E. Other sizes as indicated in the Construction Documents.

2.7 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Steel and Metallic-Coated-Steel Finishes:
 - 1. Factory Prime: Apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.
- B. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

3.3 ADJUSTING AND CLEANING

- A. Adjust doors and hardware after installation for proper operation.
- B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION 083113

SECTION 083313 - COILING METAL 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. Counter doors.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type and size of coiling counter door and accessory.
- B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.
 - 1. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
 - 2. Show locations of controls, locking devices, and other accessories.
- C. Samples for Verification: For each type of exposed finish on the following components, in manufacturer's standard sizes:
 - 1. Curtain slats.
 - 2. Bottom bar.
 - 3. Guides.
 - 4. Brackets.
 - 5. Hood.
 - 6. Locking device(s).

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For coiling counter doors to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. 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.

PART 2 - PRODUCTS

2.1 DOOR ASSEMBLY

- A. Counter Door: Coiling counter door formed with curtain of interlocking metal slats.
 - 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:
 - 2. Basis of Design Overhead Door Corporation Model 650 for both Counter doors and Full Height Overhead Doors. See schedule for types.
 - a. Alpine Overhead Doors, Inc.
 - b. Cookson Company.
 - c. Cornell Iron Works, Inc.
 - d. McKeon Rolling Steel Door Company, Inc.
 - e. MobileFlex, Inc.
- B. Operation Cycles: Door components and operators capable of operating for not less than 20,000.
- C. Door Curtain Material: Painted Steel
- D. Door Curtain Slats: Flat profile slats of 1-1/4-inch center-to-center height.
- E. Bottom Bar: Manufacturer's standard continuous channel or tubular shape, fabricated aluminum extrusion and finished to match door.
- F. Curtain Jamb Guides: Aluminum with exposed finish matching curtain slats. Provide continuous integral wear strips to prevent metal-to-metal contact and to minimize operational noise.
- G. Hood: Match curtain material and finish.
 - 1. Shape: As shown on Drawings.
 - 2. Mounting: As shown on Drawings.

- H. Locking Devices: Equip door with slide bolt for padlock.
- I. Manual Door Operator: Push-up operation.
- J. Curtain Accessories: Equip door with push/pull handles.
- K. Door Finish:
 - 1. Galvanized Steel Finish: Painted – Manufacturers Standard Options
 - 2. Interior Curtain-Slat Facing: Match finish of exterior curtain-slat face.

2.2 DOOR CURTAIN MATERIALS AND CONSTRUCTION

- A. Door Curtains: Fabricate coiling counter-door curtain of interlocking metal slats in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:
- B. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain.

2.3 HOODS

- A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.

2.4 LOCKING DEVICES

- A. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.

2.5 CURTAIN ACCESSORIES

- A. Push/Pull Handles: Equip each push-up-operated or emergency-operated door with lifting handles on each side of door, finished to match door.

2.6 COUNTERBALANCING MECHANISM

- A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.
- B. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.7 MANUAL DOOR OPERATORS

- A. General: Equip door with manual door operator by door manufacturer.
- B. All doors to be chain driven by a chain on 1 side of door. Coordinate side of drive in via shop drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install coiling counter doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.
- B. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion. Lubricate bearings and sliding parts as recommended by manufacturer. Adjust seals to provide tight fit around entire perimeter.

END OF SECTION 083313

SECTION 084113 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Exterior and interior storefront framing.
 - 2. Storefront framing for punched openings.
 - 3. Exterior and interior manual-swing entrance doors and door-frame units.

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 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 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.
- C. Samples: 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. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.
- F. Delegated-Design Submittal: For aluminum-framed storefronts indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Energy Performance Certificates: For aluminum-framed storefronts, accessories, and components, from manufacturer.
 - 1. Basis for Certification: NFRC-certified energy performance values for each aluminum-framed storefront.
- C. Product Test Reports: For aluminum-framed entrances and storefronts, for tests performed by manufacturer and witnessed by a qualified testing agency.
- D. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For aluminum-framed entrances and storefronts to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.
- C. Product Options: Information on Drawings and in Specifications establishes requirements for systems' aesthetic effects and performance characteristics. Aesthetic

effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

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.
- D. Accessible Entrances: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that 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 caused by thermal movements.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - d. Failure of operating components.
 2. Warranty Period: Five years from date of Substantial Completion.
- B. Finish Warranty: Include coverage for aluminum finishes degradation.
- C. Clear Anodized Finish or High Performance Organic Finish color as selected by Architect from manufacturer standard colors: Provide a five year manufacturer's warranty.
- D. Glass Warranty: As specified in Section 088000.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer registered in the state where the project is located, as defined in Section 014000 "Quality Requirements," to design aluminum-framed entrances and storefronts.
- B. General Performance: Aluminum-framed systems shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction:
1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure including, but not limited to, story drift, twist, column

shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.

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
2. Seismic Loads: As indicated on Drawings.

D. Deflection of Framing Members: At design wind pressure, as follows:

1. Deflection Normal to Wall Plane: Limited to $1/175$ of clear span for spans up to 13 feet 6 inches and to $1/240$ of clear span plus $1/4$ inch for spans greater than 13 feet 6 inches or an amount that restricts edge deflection of individual glazing lites to $3/4$ inch, whichever is less.
2. Deflection Parallel to Glazing Plane: Limited to $1/360$ of clear span or $1/8$ inch, whichever is smaller.
 - a. Operable Units: Provide a minimum $1/16$ -inch clearance between framing members and operable units.

E. Structural-Test Performance: Provide aluminum-framed systems tested according to ASTM E 330 as follows:

1. When tested at positive and negative wind-load design pressures, systems do not evidence deflection exceeding specified limits.
2. When tested at 150 percent of positive and negative wind-load design pressures, systems, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
3. Test Durations: As required by design wind velocity, but not fewer than 10 seconds. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:

1. Fixed Framing and Glass Area:

- a. Maximum air leakage of 0.06 cfm/sq. ft. at a static-air-pressure differential of 6.24 lbf/sq. ft.

G. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:

1. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft.

- H. Energy Performance: Certify and label energy performance according to NFRC as follows:
1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.40 Btu/sq. ft. x h x deg F as determined according to NFRC 100.
 2. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC-certified condensation resistance rating of no less than 68 as determined according to NFRC 500.
- I. Noise Reduction: Test according to ASTM E 90, with ratings determined by ASTM E 1332, as follows.
1. Outdoor-Indoor Transmission Class: Minimum 27.
- J. Thermal Movements: Provide aluminum-framed systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
 2. Test Performance: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.
 - a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F.
 - b. Low Exterior Ambient-Air Temperature: 0 deg F.
 3. Interior Ambient-Air Temperature: 75 deg F

2.2 MANUFACTURERS

- A. Basis-of-Design Products: Subject to compliance with requirements, provide EFCO 403-I Series storefront framing system, or comparable product by one of the following:
1. YKK
 2. Kawneer North America
 3. EFCO
- B. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing and accessories, from single manufacturer.

2.3 EXTERIOR FRAMING SYSTEM

- A. Framing Members: Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.
1. Construction: Thermally broken.

2. Glazing System: Retained mechanically with gaskets on four sides.
 3. Glazing Plane: As indicated.
- B. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.
- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- D. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts, complying with ASTM A 123/A 123M or ASTM A 153/A 153M.
- E. Framing System Gaskets and Sealants: Manufacturer's standard, recommended by manufacturer for joint type.
- F. Storefront Framing System:
1. Description: Center set, flush glazed; head and sill members continuous; jambs and vertical mullions attached by screw spline joinery.
 2. Components: Manufacturer's standard extruded aluminum mullions, hinged mullions, 90 degree corner posts, and indicated shapes.
 3. Thermal Barrier: Manufacturer's standard.

2.4 INTERIOR FRAMING SYSTEM

- A. Framing Members: Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.
1. Construction: Non-Thermal.
 2. Glazing System: Retained mechanically with gaskets.
 3. Glazing Plane: Center rabbet, exterior flush glazed.
- B. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- C. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts, complying with ASTM A 123/A 123M or ASTM A 153/A 153M.
- D. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
- E. Framing System Gaskets and Sealants: Manufacturer's standard, recommended by manufacturer for joint type.

2.5 MATERIALS

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
1. Sheet and Plate: ASTM B 209.

2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
3. Extruded Structural Pipe and Tubes: ASTM B 429.
4. Structural Profiles: ASTM B 308/B 308M.
5. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.

- B. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer, complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.

1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
2. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
3. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

2.6 VENTING WINDOWS

- A. Aluminum Windows: Manufacturer's standard units, complying with AAMA/WDMA/CSA 101/I.S.2/A440, with self-flashing mounting fins, and as follows:

1. Window Type: Casement, YKK SSD TU Vent.
 - a. 90-degree projection for emergency egress.
2. Minimum Performance Class: AW.
3. Minimum Performance Grade: As indicated on Drawings.
4. Aluminum Extrusions: ASTM B 221, alloy and temper recommended by manufacturer for strength, corrosion resistance, and application of required finish, but not less than 0.064-inch thickness at any location for main frame and sash members.
 - a. Thermally Improved Construction: Fabricate window units 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.
5. Mullions: Between adjacent windows, fabricated of extruded aluminum matching finish of window units.
6. Fasteners, Anchors, and Clips: Nonmagnetic stainless steel, aluminum, or other noncorrosive material, compatible with aluminum window members, trim, hardware, anchors, and other components of window units. Fasteners shall not be exposed, except for attaching hardware.
 - a. Reinforcement: Where fasteners screw-anchor into aluminum less than 0.128 inch thick, reinforce interior with aluminum or nonmagnetic stainless steel to receive screw threads, or provide standard, noncorrosive, pressed-in, spline grommet nuts.
7. Hardware: Manufacturer's standard; of aluminum, stainless steel, die-cast steel, malleable iron, or bronze; including the following:

- a. Cam-action sweep sash lock and keeper at meeting rails.
- 8. Insect Screens: Provide removable insect screen on each operable exterior sash, with screen frame finished to match window unit, complying with SMA 1004 or SMA 1201, and as follows:
 - a. Fabric: Manufacturer's standard aluminum wire fabric or glass-fiber mesh fabric.
- 9. Egress Window Identification: Provide a sticker or decal indicating which classroom window can be used for emergency egress.
- B. Glazing: Same as adjacent aluminum-framed entrances and storefront glazing.

2.7 ENTRANCE DOOR SYSTEMS

- A. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing 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.
 - 2. Door Design: Heavy duty Monumental 50 M stile; 5-inch nominal width door stiles with 10 inch bottom rail.
 - a. Accessible Doors: Smooth surfaced for width of door in area within 10 inches above floor or ground plane.
 - 3. Glazing Stops and Gaskets: Snap-on, extruded-aluminum stops and preformed gaskets to match adjacent storefront construction.
 - a. Provide nonremovable glazing stops on outside of door.

2.8 ENTRANCE DOOR HARDWARE

- A. Entrance Door Hardware: As specified in Division 08 Section "Door Hardware."

2.9 GLAZING

- A. Glazing: As specified in Division 08 Section "Glazing."
- B. Glazing Gaskets: Manufacturer's standard compression types; replaceable, molded or extruded, of profile and hardness required to maintain watertight seal.
- C. Spacers and Setting Blocks: Manufacturer's standard elastomeric type.
- D. Bond-Breaker Tape: Manufacturer's standard TFE-fluorocarbon or polyethylene material to which sealants will not develop adhesion.

2.10 ACCESSORIES

- A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, non-bleeding fasteners and accessories compatible with adjacent materials.
 - 1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 - 2. Reinforce members as required to receive fastener threads.
 - 3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.
- B. Joint Sealants: For installation at perimeter of aluminum-framed systems, as specified in Division 07 Section "Joint Sealants."
- C. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos; formulated for 30-mil thickness per coat.

2.11 FABRICATION

- A. Form or extruded aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
 - 4. Physical and thermal isolation of glazing from framing members.
 - 5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 6. Provisions for field replacement of glazing from exterior.
 - 7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
- E. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
 - 1. At exterior doors, provide compression weather stripping at fixed stops.
 - 2. At interior doors, provide silencers at stops to prevent metal-to-metal contact. Install three silencers on strike jamb of single-door frames and two silencers on head of frames for pairs of doors.

- F. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
- G. 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.
- H. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.12 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.
 - 1. DHMS - Clear Anodic
 - 2. Upper Darby HS – Dark Bronze Exterior/Black for Interior Storefront
 - 3. BHMS – No Storefront

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. General:
 - 1. Comply with manufacturer's written instructions.
 - 2. Do not install damaged components.
 - 3. Fit joints to produce hairline joints free of burrs and distortion.
 - 4. Rigidly secure non-movement joints.
 - 5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.
 - 6. Seal joints watertight unless otherwise indicated.
- B. Metal Protection:
 - 1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or applying sealant or tape, or by installing nonconductive spacers as recommended by manufacturer for this purpose.
 - 2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- C. Set continuous sill members and flashing in full sealant bed as specified in Division 07 Section "Joint Sealants" to produce weathertight installation.

- D. Install components plumb and true in alignment with established lines and grades, and without warp or rack.
- E. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.
- F. Install glazing as specified in Division 08 Section "Glazing."
- G. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.
 - 1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
 - 2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.
- H. Install weatherseal sealant as specified in Division 07 Section "Joint Sealants" to produce weathertight installation.
- I. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.
 - 1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.

3.3 ERECTION TOLERANCES

- A. Erection Tolerances: 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.

3.4 ADJUSTING

- A. Adjust operating entrance door hardware to function smoothly as recommended by manufacturer.

1. For entrance doors accessible to people with disabilities, adjust closers to provide a 3-second closer sweep period for doors to move from a 70-degree open position to 3 inches from the latch, measured to the leading door edge.

END OF SECTION 084113

SECTION 087100.1 - DOOR HARDWARE - BHMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes commercial door hardware for the following:
 - 1. Swinging doors.
- B. Door hardware includes, but is not necessarily limited to, the following:
 - 1. Mechanical door hardware.
 - 2. Electromechanical door hardware.
- C. Related Sections:
 - 1. Division 08 Section "Flush Wood Doors".
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
 - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
 - 2. ICC/IBC - International Building Code.
 - 3. NFPA 70 - National Electrical Code.
 - 4. NFPA 80 - Fire Doors and Windows.
 - 5. NFPA 101 - Life Safety Code.
 - 6. NFPA 105 - Installation of Smoke Door Assemblies.
 - 7. State Building Codes, Local Amendments.
- E. Standards: All hardware specified herein shall comply with the following industry standards as applicable. Any undated reference to a standard shall be interpreted as referring to the latest edition of that standard:
 - 1. ANSI/BHMA Certified Product Standards - A156 Series.
 - 2. UL10C - Positive Pressure Fire Tests of Door Assemblies.
 - 3. ANSI/UL 294 - Access Control System Units.

4. UL 305 - Panic Hardware.
5. ANSI/UL 437- Key Locks.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing, fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
 3. Content: Include the following information:
 - a. Type, style, function, size, label, hand, and finish of each door hardware item.
 - b. Manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - e. Explanation of abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for door hardware.
 - g. Door and frame sizes and materials.
 - h. Warranty information for each product.
 4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- C. Shop Drawings: Details of electrified access control hardware indicating the following:

1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:
 - a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
 - b. Complete (risers, point-to-point) access control system block wiring diagrams.
 - c. Wiring instructions for each electronic component scheduled herein.
 2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.
- D. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.
- E. Informational Submittals:
1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.
- F. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.
- 1.4 QUALITY ASSURANCE
- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.
 - B. Certified Products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).
 - C. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

- D. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.
- E. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.
1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
 2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.
- F. Each unit to bear third party permanent label indicating compliance with the referenced testing standards.
- G. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:
1. Function of building, purpose of each area and degree of security required.
 2. Plans for existing and future key system expansion.
 3. Requirements for key control storage and software.
 4. Installation of permanent keys, cylinder cores and software.
 5. Address and requirements for delivery of keys.
- H. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.
1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
 2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.

3. Review sequence of operation narratives for each unique access controlled opening.
 4. Review and finalize construction schedule and verify availability of materials.
 5. Review the required inspecting, testing, commissioning, and demonstration procedures
- I. At completion of installation, provide written documentation that components were applied according to manufacturer's instructions and recommendations and according to approved schedule.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.6 COORDINATION

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.
- B. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

- B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:
1. Structural failures including excessive deflection, cracking, or breakage.
 2. Faulty operation of the hardware.
 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 4. Electrical component defects and failures within the systems operation.
- C. Warranty Period: Unless otherwise indicated, warranty shall be one year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.
- B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:
1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.
- C. Please note that ASSA ABLOY is transitioning the Yale Commercial brand to Arrow. This affects only the brand name; the products and product numbers will remain unchanged. The brand transition is expected to be complete in or about May of 2024, and products shipping after that time will be branded Arrow.
- D. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.2 BUTT HINGES

- A. Hinges: ANSI/BHMA A156.1 butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.

1. Quantity: Provide the following hinge quantity:
 - a. Two Hinges: For doors with heights up to 60 inches.
 - b. Three Hinges: For doors with heights 61 to 90 inches.
 - c. Four Hinges: For doors with heights 91 to 120 inches.
 - d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
 - a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
 - b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.
3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
 - a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
 - b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
4. Hinge Options: Comply with the following:
 - a. Non-removable Pins: With the exception of electric through wire hinges, provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.
5. Manufacturers:
 - a. McKinney (MK) - TA/T4A Series, 5 knuckle.

2.3 CYLINDERS AND KEYING

- A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.

1. Manufacturers:

- a. Match Existing, Field Verify.
- B. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:
 - 1. Threaded mortise cylinders with rings and cams to suit hardware application.
 - 2. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
 - 3. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.
 - 4. Tubular deadlocks and other auxiliary locks.
 - 5. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
 - 6. Keyway: Match Facility Standard.
- C. Keying System: Each type of lock and cylinders to be factory keyed.
 - 1. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.
 - 2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
 - 3. Existing System: Field verify and key cylinders to match Owner's existing system.
- D. Key Quantity: Provide the following minimum number of keys:
 - 1. Change Keys per Cylinder: Two (2)
 - 2. Master Keys (per Master Key Level/Group): Five (5).
 - 3. Construction Keys (where required): Ten (10).
- E. Construction Keying: Provide construction master keyed cylinders.
- F. Key Registration List (Bitting List):
 - 1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
 - 2. Provide transcript list in writing or electronic file as directed by the Owner.

2.4 LOCK AND LATCH STRIKES

- A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:
 - 1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
 - 2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.

3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.

B. Standards: Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.
2. Strikes for Bored Locks and Latches: BHMA A156.2.
3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
4. Dustproof Strikes: BHMA A156.16.

2.5 CONVENTIONAL EXIT DEVICES

A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. Exit devices shall have a five-year warranty.
2. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.
3. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer's catalog and template book for specific requirements.
4. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.
5. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.
6. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.
 - a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
 - b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.

7. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.
 8. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.
 9. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
 10. Rail Sizing: Provide exit device rails factory sized for proper door width application.
 11. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.
- B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Exit device latch to be stainless steel, pullman type, with deadlock feature.
1. Manufacturers:
 - a. Arrow, formerly known as Yale (YA) - 7000 Series.

2.6 DOOR CLOSERS

- A. All door closers specified herein shall meet or exceed the following criteria:
1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.
 2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
 3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.
 4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.

5. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
 6. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.
- B. Door Closers, Surface Mounted (Heavy Duty): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units standard.
1. Heavy duty surface mounted door closers shall have a 30-year warranty.
 2. Manufacturers:
 - a. Arrow, formerly known as Yale (YA) - 4400 Series.

2.7 SURFACE MOUNTED CLOSER HOLDERS

- A. Electromagnetic Door Holders: ANSI A156.15 electromagnetic door holder/releases with a minimum 20 to 40 pounds holding power and single coil construction able to accommodate 12VDC, 24VAC, 24VDC and 120VAC. Coils to be independently wound, employing an integral fuse and armatures to include a positive release button.
1. Manufacturers:
 - a. Norton Rixson (RF) - 980/990 Series.

2.8 ARCHITECTURAL TRIM

- A. Door Protective Trim
1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
 2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1" LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.

3. Where plates are applied to fire rated doors with the top of the plate more than 16" above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer's catalog and template book for specific requirements for size and applications.
4. Protection Plates: ANSI/BHMA A156.6 protection plates (kick, armor, or mop), fabricated from the following:
 - a. Stainless Steel: 300 grade, 050-inch thick.
5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
6. Manufacturers:
 - a. Rockwood (RO).

2.9 DOOR STOPS AND HOLDERS

- A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.

2.10 ARCHITECTURAL SEALS

- A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.
- B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.
 1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.
- C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.
 1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NPFA 252, Standard Methods of Fire Tests of Door Assemblies.

- D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.
- E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- F. Manufacturers:
 - 1. Pemko (PE).

2.11 FABRICATION

- A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.12 FINISHES

- A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

- A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.
- B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

- A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
 - 1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.
- B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 2. DHI TDH-007-20: Installation Guide for Doors and Hardware.
 - 3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
 - 4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.
- C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
- D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."
- E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

- A. Field Inspection (Punch Report): Reference Division 01 Sections "Closeout Procedures". Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.
 - 1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.

3.5 ADJUSTING

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

3.6 CLEANING AND PROTECTION

- A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.
- B. Clean adjacent surfaces soiled by door hardware installation.
- C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

- A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 DOOR HARDWARE SETS

- A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted

items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

1. Quantities listed are for each pair of doors, or for each single door.
2. The supplier is responsible for handing and sizing all products.
3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.
4. At existing openings with new hardware the supplier shall field inspect existing conditions prior to the submittal stage to verify the specified hardware will work as required. Provide alternate solutions and proposals as needed.

B. Manufacturer's Abbreviations:

1. MK - McKinney
2. YA - Arrow, formerly known as Yale
3. RO - Rockwood
4. RF - Rixson
5. PE - Pemko

Hardware Sets

Set: 1.0

Doors: 201, 202

6 Hinge, Full Mortise, Hvy Wt	T4A3786 [NRP]	US26D	MK
1 Fire Rated Surf Vert Rod, Classroom	7170F LBR AU626F	630	YA
1 Fire Rated Surf Vert Rod, Exit Only	7170F LBR EO	630	YA
1 Cylinder	As Required to Match Facility Standard		
2 Surface Closer	PR4400	689	YA
2 Kick Plate	K1050 10" high CSK BEV	US32D	RO
2 Electromagnetic Holder	996M X Voltage & Mounting Accessories As Required)	689	RF ⚡
1 Gasketing	S88BL (Head & Jambs)		PE
1 Astragal	297AS x Door Height		PE

Notes:

Doors are magnetically held open. Integrate with fire alarm system to release upon fire alarm activation.

Verify and coordinate scheduled hardware with existing conditions prior to ordering. Prepare existing frame and provide all filler plates and accessories required for proper installation and function of new hardware.

Set: 2.0

Doors: 101, 102, 103, 104, 203

8 Hinge, Full Mortise, Hvy Wt	T4A3786 [NRP]	US26D	MK
1 Fire Rated Surf Vert Rod, Classroom	7170F LBR AU626F	630	YA
1 Fire Rated Surf Vert Rod, Exit Only	7170F LBR EO	630	YA
1 Cylinder	As Required to Match Facility Standard		
2 Surface Closer	PR4400	689	YA
2 Kick Plate	K1050 10" high CSK BEV	US32D	RO
2 Electromagnetic Holder	996M X Voltage & Mounting Accessories As Required)	689	RF ⚡
1 Gasketing	S88BL (Head & Jambs)		PE
1 Astragal	297AS x Door Height		PE

Notes:

Doors are magnetically held open. Integrate with fire alarm system to release upon fire alarm activation.

Verify and coordinate scheduled hardware with existing conditions prior to ordering. Prepare existing frame and provide all filler plates and accessories required for proper installation and function of new hardware.

END OF SECTION 087100

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SECTION 087100.2 - DOOR HARDWARE – DHMS LOCKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes commercial door hardware for the following:
 - 1. Swinging doors.
- B. Door hardware includes, but is not necessarily limited to, the following:
 - 1. Mechanical door hardware.
 - 2. Electromechanical door hardware.
- C. Related Sections:
 - 1. Division 08 Section "Hollow Metal Doors and Frames".
 - 2. Division 08 Section "Flush Wood Doors".
 - 3. Division 08 Section "Fiberglass Doors",
 - 4. Division 08 Section "Aluminum-Framed Entrances and Storefronts".
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
 - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
 - 2. ICC/IBC - International Building Code.
 - 3. NFPA 70 - National Electrical Code.
 - 4. NFPA 80 - Fire Doors and Windows.
 - 5. NFPA 101 - Life Safety Code.
 - 6. NFPA 105 - Installation of Smoke Door Assemblies.
 - 7. State Building Codes, Local Amendments.
- E. Standards: All hardware specified herein shall comply with the following industry standards as applicable. Any undated reference to a standard shall be interpreted as referring to the latest edition of that standard:

1. ANSI/BHMA Certified Product Standards - A156 Series.
2. UL10C - Positive Pressure Fire Tests of Door Assemblies.
3. ANSI/UL 294 - Access Control System Units.
4. UL 305 - Panic Hardware.
5. ANSI/UL 437- Key Locks.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing, fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
 3. Content: Include the following information:
 - a. Type, style, function, size, label, hand, and finish of each door hardware item.
 - b. Manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - e. Explanation of abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for door hardware.
 - g. Door and frame sizes and materials.
 - h. Warranty information for each product.
 4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

- C. Shop Drawings: Details of electrified access control hardware indicating the following:
1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:
 - a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
 - b. Complete (risers, point-to-point) access control system block wiring diagrams.
 - c. Wiring instructions for each electronic component scheduled herein.
 2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.
- D. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.
- E. Informational Submittals:
1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.
- F. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.

1.4 QUALITY ASSURANCE

- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.
- B. Certified Products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).

- C. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- D. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.
- E. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.
 - 1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
 - 2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.
- F. Each unit to bear third party permanent label indicating compliance with the referenced testing standards.
- G. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:
 - 1. Function of building, purpose of each area and degree of security required.
 - 2. Plans for existing and future key system expansion.
 - 3. Requirements for key control storage and software.
 - 4. Installation of permanent keys, cylinder cores and software.
 - 5. Address and requirements for delivery of keys.
- H. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.
 - 1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum,

- hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
 3. Review sequence of operation narratives for each unique access controlled opening.
 4. Review and finalize construction schedule and verify availability of materials.
 5. Review the required inspecting, testing, commissioning, and demonstration procedures
- I. At completion of installation, provide written documentation that components were applied according to manufacturer's instructions and recommendations and according to approved schedule.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.6 COORDINATION

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.
- B. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:
 - 1. Structural failures including excessive deflection, cracking, or breakage.
 - 2. Faulty operation of the hardware.
 - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 4. Electrical component defects and failures within the systems operation.
- C. Warranty Period: Unless otherwise indicated, warranty shall be one year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.
- B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:
 - 1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.
- C. Please note that ASSA ABLOY is transitioning the Yale Commercial brand to Arrow. This affects only the brand name; the products and product numbers will remain unchanged. The brand transition is expected to be complete in or about May of 2024, and products shipping after that time will be branded Arrow.

- D. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.2 BUTT HINGES

- A. Hinges: ANSI/BHMA A156.1 butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.
1. Quantity: Provide the following hinge quantity:
 - a. Two Hinges: For doors with heights up to 60 inches.
 - b. Three Hinges: For doors with heights 61 to 90 inches.
 - c. Four Hinges: For doors with heights 91 to 120 inches.
 - d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
 2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
 - a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
 - b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.
 3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
 - a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
 - b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
 4. Hinge Options: Comply with the following:
 - a. Non-removable Pins: With the exception of electric through wire hinges, provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.
 5. Manufacturers:
 - a. McKinney (MK) - TA/T4A Series, 5 knuckle.

2.3 CONTINUOUS HINGES

- A. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 continuous geared hinge. with minimum 0.120-inch thick extruded 6063-T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cut-outs.

1. Manufacturers:
 - a. Pemko (PE).

2.4 POWER TRANSFER DEVICES

- A. Concealed Quick Connect Electric Power Transfers: Provide concealed wiring pathway housing mortised into the door and frame for low voltage electrified door hardware. Furnish with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Manufacturers:
 - a. Securitron (SU) - EL-CEPT Series.

- B. Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.

1. Provide one each of the following tools as part of the base bid contract:
 - a. McKinney (MK) - Electrical Connecting Kit: QC-R001.
 - b. McKinney (MK) - Connector Hand Tool: QC-R003.
2. Manufacturers:
 - a. McKinney (MK) - QC-C Series.

2.5 DOOR OPERATING TRIM

- A. Door Push Plates and Pulls: ANSI/BHMA A156.6 door pushes and pull units of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.
1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
 2. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
 3. Pulls, where applicable, shall be provided with a 10" clearance from the finished floor on the push side to accommodate wheelchair accessibility.
 4. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.
 5. Manufacturers:
 - a. Rockwood (RO).

2.6 CYLINDERS AND KEYING

- A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.
1. Manufacturers:
 - a. Match Existing, Field Verify.
- B. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:
1. Threaded mortise cylinders with rings and cams to suit hardware application.
 2. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
 3. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.
 4. Tubular deadlocks and other auxiliary locks.
 5. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
 6. Keyway: Manufacturer's Standard.
- C. Keying System: Each type of lock and cylinders to be factory keyed.

1. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.
2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
3. Existing System: Field verify and key cylinders to match Owner's existing system.

D. Key Quantity: Provide the following minimum number of keys:

1. Change Keys per Cylinder: Two (2)
2. Master Keys (per Master Key Level/Group): Five (5).
3. Construction Keys (where required): Ten (10).

E. Construction Keying: Provide construction master keyed cylinders.

F. Key Registration List (Bitting List):

1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
2. Provide transcript list in writing or electronic file as directed by the Owner.

2.7 MECHANICAL LOCKS AND LATCHING DEVICES

A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.

1. Heavy duty mortise locks shall have a ten-year warranty.
2. Where specified, provide status indicators with highly reflective color and wording for "locked/unlocked" or "vacant/occupied" with custom wording options if required. Indicator to be located above the cylinder with the inside thumb-turn not blocking the visibility of the indicator status. Indicator window size to be a minimum of 2.1" x 0.6" with a curved design allowing a 180-degree viewing angle with protective covering to prevent tampering.
3. Manufacturers:
 - a. Arrow, formerly known as Yale (YA) - 8800FL Series.

B. Cylindrical Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.2, Series 4000, Operational Grade 1 Certified Products Directory (CPD) listed.

1. Vertical Impact: Exceed 100 vertical impacts (20 times ANSI/BHMA A156.2 requirements).

2. Furnish with solid cast levers, standard 2 3/4" backset, and 1/2" (3/4" at rated paired openings) throw brass or stainless steel latchbolt.
3. Locks are to be non-handed and fully field reversible.
4. Manufacturers:
 - a. Arrow, formerly known as Yale (YA) – 5400LN Series.

2.8 LOCK AND LATCH STRIKES

- A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:
 1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
 2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
 3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
 4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.
- B. Standards: Comply with the following:
 1. Strikes for Mortise Locks and Latches: BHMA A156.13.
 2. Strikes for Bored Locks and Latches: BHMA A156.2.
 3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
 4. Dustproof Strikes: BHMA A156.16.

2.9 CONVENTIONAL EXIT DEVICES

- A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:
 1. Exit devices shall have a five-year warranty.
 2. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.

3. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer's catalog and template book for specific requirements.
 4. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.
 5. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.
 6. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.
 - a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
 - b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.
 7. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.
 8. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.
 9. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
 10. Rail Sizing: Provide exit device rails factory sized for proper door width application.
 11. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.
- B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Exit device latch to be stainless steel, pullman type, with deadlock feature.
1. Manufacturers:
 - a. Arrow, formerly known as Yale (YA) - 7000 Series.

- C. Steel Removable Mullions: ANSI/BHMA A156.3 steel removable mullions with options for fire rating, locking, through-wire electrification and hurricane compliance as specified.

1. Manufacturers:
 - a. Same as exit device manufacturer.

2.10 ELECTROMECHANICAL EXIT DEVICES

- A. Electromechanical Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed panic and fire exit hardware devices subject to same compliance standards and requirements as mechanical exit devices. Electrified exit devices to be of type and design as specified below and in the hardware sets.
1. Energy Efficient Design: Provide devices which have a holding current draw of 15mA maximum, and can operate on either 12 or 24 volts. Locks are to be field configurable for fail safe or fail secure operation.
 2. Where conventional power supplies are not sufficient, include any specific controllers required to provide the proper inrush current.
 3. Motorized Electric Latch Retraction: Devices with an electric latch retraction feature must use motors which have a maximum current draw of 600mA. Solenoid driven latch retraction is not acceptable.
 4. Manufacturers:
 - a. Arrow, formerly known as Yale (YA) - 7000 Series.

2.11 DOOR CLOSERS

- A. All door closers specified herein shall meet or exceed the following criteria:
1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.
 2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
 3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated

frequency of use. Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.

4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
 5. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
 6. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.
- B. Door Closers, Surface Mounted (Heavy Duty): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units standard.
1. Heavy duty surface mounted door closers shall have a 30-year warranty.
 2. Manufacturers:
 - a. Arrow, formerly known as Yale (YA) - 4400 Series.

2.12 ARCHITECTURAL TRIM

A. Door Protective Trim

1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1" LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.
3. Where plates are applied to fire rated doors with the top of the plate more than 16" above the bottom of the door, provide plates complying with NFPA 80.

Consult manufacturer's catalog and template book for specific requirements for size and applications.

4. Protection Plates: ANSI/BHMA A156.6 protection plates (kick, armor, or mop), fabricated from the following:
 - a. Stainless Steel: 300 grade, 050-inch thick.
5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
6. Manufacturers:
 - a. Rockwood (RO).

2.13 DOOR STOPS AND HOLDERS

- A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.
- B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.
 1. Manufacturers:
 - a. Rockwood (RO).
- C. Overhead Door Stops and Holders: ANSI/BHMA A156.8, Grade 1 Certified Products Directory (CPD) listed overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.
 1. Manufacturers:
 - a. Norton Rixson (RF).

2.14 ARCHITECTURAL SEALS

- A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on

exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.

- B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.
 - 1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.
- C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.
 - 1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NPFA 252, Standard Methods of Fire Tests of Door Assemblies.
- D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.
- E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- F. Manufacturers:
 - 1. Pemko (PE).

2.15 ELECTRONIC ACCESSORIES

- A. Door Position Switches: Door position magnetic reed contact switches specifically designed for use in commercial door applications. On recessed models the contact and magnetic housing snap-lock into a 1" diameter hole. Surface mounted models include wide gap distance design complete with armored flex cabling. Provide SPDT, N/O switches with optional Rare Earth Magnet installation on steel doors with flush top channels.
 - 1. Manufacturers:
 - a. Securitron (SU) - DPS Series.
- B. Intelligent Switching Power Supplies: Provide power supplies with single, dual or multi-voltage configurations at 12 and/or 24VDC. Power Supply shall have battery backup function with an integrated battery charging circuit. The power supply shall have a standard, integrated Fire Alarm Interface (FAI). The power supply shall provide

capability for secondary voltage, power distribution, direct lock control and network monitoring through add on modules. The power supply shall be expandable up to 16 individually protected outputs. Output modules shall provide individually protected, continuous outputs and/or individually protected, relay controlled outputs. Network modules shall provide remote monitoring functions such as status reporting, fault reporting and information logging.

1. Provide the least number of units, at the appropriate amperage level, sufficient to exceed the required total draw for the specified electrified hardware and access control equipment.
2. Manufacturers:
 - a. Securitron (SU) - AQL Series.

2.16 FABRICATION

- A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.17 FINISHES

- A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

- B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

- A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.
- B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

- A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
 - 1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.
- B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 2. DHI TDH-007-20: Installation Guide for Doors and Hardware.
 - 3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
 - 4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.
- C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
- D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

- E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

- A. Field Inspection (Punch Report): Reference Division 01 Sections "Closeout Procedures". Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.
 - 1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.

3.5 ADJUSTING

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

3.6 CLEANING AND PROTECTION

- A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.
- B. Clean adjacent surfaces soiled by door hardware installation.
- C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

- A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 DOOR HARDWARE SETS

A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

1. Quantities listed are for each pair of doors, or for each single door.
2. The supplier is responsible for handling and sizing all products.
3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.
4. At existing openings with new hardware the supplier shall field inspect existing conditions prior to the submittal stage to verify the specified hardware will work as required. Provide alternate solutions and proposals as needed.

B. Manufacturer's Abbreviations:

1. MK - McKinney
2. PE - Pemko
3. SU - Securitron
4. YA - Arrow, formerly known as Yale
5. RO - Rockwood
6. RF - Rixson

Hardware Sets

Set: 1.0

Doors: A110B, A118B

2 Continuous Hinge	CFM_SLF-HD1 x Length Required x PT		PE	
2 Electric Power Transfer	EL-CEPT	630	SU	⚡
1 Mullion	KRM200 x Length Required	600	YA	
1 Rim Exit Device, Nightlatch	7100 B MELR 121NL Less Dogging	630	YA	⚡

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1 Rim Exit Device, Exit Only	7100 B EO Less Dogging	630	YA	⚡
2 Cylinder	As Required to Match Facility Standard			
1 Pull	RM201 Mtg-Type 12XHD	US32D- 316	RO	
2 Surface Closer	4430	689	YA	
1 Threshold	273x224AFGT x Length Required x MSES25SS		PE	
1 Gasketing	Provided by Frame Supplier			
1 Gasketing	297AS x Door Height		PE	
1 Mullion Gasketing	5110BL x Length Required		PE	
2 Sweep	3452CNB x Length Required		PE	
1 Card Reader	Provided By Security Supplier			
2 ElectroLynx Harness	QC-C**** x Length Required		MK	⚡
2 ElectroLynx Harness	QC-C1500P		MK	⚡
2 Position Switch	DPS-M-BK		SU	⚡
1 Power Supply	AQL4-R8E1		SU	⚡
1 Wiring Diagram	Elevation and Point to Point as Specified			

Notes:

SYSTEM OPERATIONAL NARRATIVE

Doors normally closed and secured.

Presenting valid credential to card reader temporarily retracts latch allowing entry.

Entry also possible via key override.

Free egress at all times.

Request to exit switches, incorporated in exit device push pads, signal an egress.

Door position switches monitor the doors open/closed status.

Latches remain projected during power loss. (Fail Secure)

Set: 2.0

Doors: A110A

2 Continuous Hinge	CFM_SLF-HD1 x Length Required x PT		PE	
2 Electric Power Transfer	EL-CEPT	630	SU	⚡
1 Electrified SVR Exit, Fail Secure	7170 LBR B AU691F Less Dogging	630	YA	⚡
1 Surface Vert Rod Exit, Exit Only	7170 LBR B EO Less Dogging	630	YA	⚡

1 Cylinder	As Required to Match Facility Standard			
2 Surface Closer	PR4400 / 4400 (As Condition Requires)	689	YA	
2 Door Stop	403 (or) 441CU (As Condition Requires)	US26D	RO	
1 Gasketing	Provided by Frame Supplier			
1 Card Reader	Provided By Security Supplier			
2 ElectroLynx Harness	QC-C**** x Length Required		MK	⚡
2 ElectroLynx Harness	QC-C1500P		MK	⚡
2 Position Switch	DPS-M-BK		SU	⚡
1 Power Supply	AQL4-R8E1		SU	⚡
1 Wiring Diagram	Elevation and Point to Point as Specified			

Notes:

SYSTEM OPERATIONAL NARRATIVE

Doors normally closed and secured.

Presenting valid credential to card reader temporarily unlocks lever allowing entry.

Entry also possible via key override.

Free egress at all times.

Request to exit switches, incorporated in exit device push pads, signal an egress.

Door position switches monitor the doors open/closed status.

Latches remain projected during power loss. (Fail Secure)

Set: 3.0

Doors: A111D

2 Continuous Hinge	CFM_SLF-HD1-M x Length Required		PE	
1 Mullion	KRM200 x Length Required	600	YA	
1 Rim Exit Device, Exit Only	7100 EO Less Dogging	630	YA	
1 Cylinder	As Required to Match Facility Standard			
2 Surface Closer	4430	689	YA	
1 Threshold	273x224AFGT x Length Required x MSES25SS		PE	
1 Gasketing	Provided by Frame Supplier			
1 Gasketing	297AS x Door Height		PE	

1 Mullion Gasketing	5110BL x Length Required	PE	
2 Sweep	3452CNB x Length Required	PE	
2 Position Switch	DPS-M-BK	SU	⚡

Notes:

SYSTEM OPERATIONAL NARRATIVE

Door position switches monitor the doors open/closed status.

Set: 4.0

Doors: A111C

6 Hinge	T4A3786 [NRP]	US26D	MK
1 Fire Rated Surf Vert Rod, Classroom	7170F LBR AU626F	630	YA
1 Fire Rated Surf Vert Rod, Exit Only	7170F LBR EO	630	YA
1 Cylinder	As Required to Match Facility Standard		
2 Surface Closer	PR4400 / 4400 (As Condition Requires)	689	YA
2 Kick Plate	K1050 10" high CSK BEV	US32D	RO
2 Door Stop	403 (or) 441CU (As Condition Requires)	US26D	RO
2 Gasketing	S88BL (Head & Jambs)		PE
1 Gasketing	297AS x Door Height		PE

Set: 5.0

Doors: A103A

2 Continuous Hinge	CFM_SLF-HD1-M x Length Required		PE
1 Fire Rated Surf Vert Rod, Classroom	7170F LBR AU626F	630	YA
1 Fire Rated Surf Vert Rod, Exit Only	7170F LBR EO	630	YA
1 Cylinder	As Required to Match Facility Standard		
2 Surface Closer	PR4400 / 4400 (As Condition Requires)	689	YA
2 Door Stop	403 (or) 441CU (As Condition Requires)	US26D	RO

1 Gasketing	Provided by Frame Supplier		
1 Gasketing	297AS x Door Height		PE

Set: 6.0

Doors: A102

3 Hinge	T4A3786 [NRP]	US26D	MK
1 Rim Exit Device, Classroom	7105 AU626F	630	YA
2 Cylinder	As Required to Match Facility Standard		
1 Surface Closer	PR4400 / 4400 (As Condition Requires)	689	YA
1 Kick Plate	K1050 10" high CSK BEV	US32D	RO
1 Door Stop	403 (or) 441CU (As Condition Requires)	US26D	RO
3 Silencer	608		RO

Set: 7.0

Doors: A104, A107, A113, A115, A116

3 Hinge	TA2714 [NRP]	US26D	MK
1 Storeroom or Closet Lock	AU 5405LN	626	YA
1 Cylinder	As Required to Match Facility Standard		
1 Door Stop	403 (or) 441CU (As Condition Requires)	US26D	RO
1 Silencer	608		RO

Set: 8.0

Doors: A106

3 Hinge	TA2714 [NRP]	US26D	MK
1 Storeroom or Closet Lock	AU 5405LN	626	YA
1 Cylinder	As Required to Match Facility Standard		
1 Surf Overhead Stop	10-X36	630	RF
3 Silencer	608		RO

Set: 9.0

Doors: A108, A114

3 Hinge	TA2714 [NRP]	US26D	MK
1 Storeroom or Closet Lock	AU 5405LN	626	YA
1 Cylinder	As Required to Match Facility Standard		
1 Surface Closer	PR4400 / 4400 (As Condition Requires)	689	YA
1 Kick Plate	K1050 10" high CSK BEV	US32D	RO
1 Door Stop	403 (or) 441CU (As Condition Requires)	US26D	RO
3 Silencer	608		RO

Set: 10.0

Doors: A101

3 Hinge	TA2714 [NRP]	US26D	MK
1 Storeroom or Closet Lock	AU 5405LN	626	YA
1 Cylinder	As Required to Match Facility Standard		
1 Surface Closer	PR4400 / 4400 (As Condition Requires)	689	YA
1 Kick Plate	K1050 10" high CSK BEV	US32D	RO
1 Door Stop	403 (or) 441CU (As Condition Requires)	US26D	RO
1 Gasketing	S88BL (Head & Jambs)		PE

Set: 11.0

Doors: A105

3 Hinge	TA2714 [NRP]	US26D	MK
1 Entry Lock	AU 5404LN	626	YA
1 Cylinder	As Required to Match Facility Standard		
1 Door Stop	403 (or) 441CU (As Condition Requires)	US26D	RO
1 Gasketing	S88BL (Head & Jambs)		PE

Set: 12.0

Doors: A112

3 Hinge	TA2714 [NRP]	US26D	MK
1 Entry Lock	AU 5404LN	626	YA
1 Cylinder	As Required to Match Facility Standard		
1 Surf Overhead Stop	10-X36	630	RF
1 Gasketing	S88BL (Head & Jambs)		PE

Set: 13.0

Doors: A109, A117

3 Hinge	TA2714 [NRP]	US26D	MK
1 Classroom Lock	AU 5408LN	626	YA
1 Cylinder	As Required to Match Facility Standard		
1 Door Stop	403 (or) 441CU (As Condition Requires)	US26D	RO
1 Silencer	608		RO

Set: 14.0

Doors: T102, T108

3 Hinge	TA2714 [NRP]	US26D	MK
1 Privacy Lock	AUR 8802FL V21	626	YA
1 Kick Plate	K1050 10" high CSK BEV	US32D	RO
1 Door Stop	403 (or) 441CU (As Condition Requires)	US26D	RO
1 Silencer	608		RO

Set: 15.0

Doors: T104, T109

3 Hinge	TA2714 [NRP]	US26D	MK
1 Privacy Lock	AUR 8802FL V21	626	YA
1 Surf Overhead Stop	10-X36	630	RF

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1 Kick Plate	K1050 10" high CSK BEV	US32D	RO
1 Silencer	608		RO

Set: 16.0

Doors: T101, T107

3 Hinge	TA2714 [NRP]	US26D	MK
1 Privacy Lock	AUR 8802FL V21	626	YA
1 Surface Closer	PR4400 / 4400 (As Condition Requires)	689	YA
1 Kick Plate	K1050 10" high CSK BEV	US32D	RO
1 Door Stop	403 (or) 441CU (As Condition Requires)	US26D	RO
1 Gasketing	S88BL (Head & Jambs)		PE

Set: 17.0

Doors: A103B, A103C, A111A, A111B, T105

3 Hinge	T4A3786 [NRP]	US26D	MK
1 Mortise Deadlock	356	626	YA
1 Cylinder	As Required to Match Facility Standard		
1 Pull Plate	BF 110x70C	US32D	RO
1 Push Plate	70C-RKW	US32D	RO
1 Surface Closer	PR4400 / 4400 (As Condition Requires)	689	YA
2 Kick Plate	K1050 10" high CSK BEV	US32D	RO
1 Door Stop	403 (or) 441CU (As Condition Requires)	US26D	RO
3 Silencer	608		RO

Set: 18.0

Doors: T106

3 Hinge	T4A3786 [NRP]	US26D	MK
1 Mortise Deadlock	356	626	YA
1 Cylinder	As Required to Match Facility Standard		

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1 Pull Plate	BF 110x70C	US32D	RO
1 Push Plate	70C-RKW	US32D	RO
1 Surface Closer	4430	689	YA
1 Kick Plate	K1050 10" high CSK BEV	US32D	RO
3 Silencer	608		RO

Set: 19.0

Doors: A118A

6 Hinge	T4A3786 [NRP]	US26D	MK
1 Pull Plate	BF 110x70C	US32D	RO
1 Push Plate	70C-RKW	US32D	RO
2 Surface Closer	PR4400 / 4400 (As Condition Requires)	689	YA
2 Door Stop	403 (or) 441CU (As Condition Requires)	US26D	RO
1 Gasketing	Provided by Frame Supplier		

END OF SECTION 087100

SECTION 087100.3 - DOOR HARDWARE - UDHS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes commercial door hardware for the following:
 - 1. Swinging doors.
- B. Door hardware includes, but is not necessarily limited to, the following:
 - 1. Mechanical door hardware.
 - 2. Electromechanical door hardware.
- C. Related Sections:
 - 1. Division 08 Section "Hollow Metal Doors and Frames".
 - 2. Division 08 Section "Flush Wood Doors".
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
 - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
 - 2. ICC/IBC - International Building Code.
 - 3. NFPA 70 - National Electrical Code.
 - 4. NFPA 80 - Fire Doors and Windows.
 - 5. NFPA 101 - Life Safety Code.
 - 6. NFPA 105 - Installation of Smoke Door Assemblies.
 - 7. State Building Codes, Local Amendments.
- E. Standards: All hardware specified herein shall comply with the following industry standards as applicable. Any undated reference to a standard shall be interpreted as referring to the latest edition of that standard:
 - 1. ANSI/BHMA Certified Product Standards - A156 Series.
 - 2. UL10C - Positive Pressure Fire Tests of Door Assemblies.

3. ANSI/UL 294 - Access Control System Units.
4. UL 305 - Panic Hardware.
5. ANSI/UL 437- Key Locks.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing, fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
 3. Content: Include the following information:
 - a. Type, style, function, size, label, hand, and finish of each door hardware item.
 - b. Manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - e. Explanation of abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for door hardware.
 - g. Door and frame sizes and materials.
 - h. Warranty information for each product.
 4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- C. Shop Drawings: Details of electrified access control hardware indicating the following:

1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:
 - a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
 - b. Complete (risers, point-to-point) access control system block wiring diagrams.
 - c. Wiring instructions for each electronic component scheduled herein.
 2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.
- D. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.
- E. Informational Submittals:
1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.
- F. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.
- 1.4 QUALITY ASSURANCE
- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.
 - B. Certified Products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).
 - C. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

- D. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.
- E. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.
1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
 2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.
- F. Each unit to bear third party permanent label indicating compliance with the referenced testing standards.
- G. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:
1. Function of building, purpose of each area and degree of security required.
 2. Plans for existing and future key system expansion.
 3. Requirements for key control storage and software.
 4. Installation of permanent keys, cylinder cores and software.
 5. Address and requirements for delivery of keys.
- H. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.
1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
 2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
 3. Review sequence of operation narratives for each unique access controlled opening.

4. Review and finalize construction schedule and verify availability of materials.
5. Review the required inspecting, testing, commissioning, and demonstration procedures

- I. At completion of installation, provide written documentation that components were applied according to manufacturer's instructions and recommendations and according to approved schedule.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.6 COORDINATION

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.
- B. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or

workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.
 2. Faulty operation of the hardware.
 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 4. Electrical component defects and failures within the systems operation.
- C. Warranty Period: Unless otherwise indicated, warranty shall be one year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.
- B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:
1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.
- C. Please note that ASSA ABLOY is transitioning the Yale Commercial brand to Arrow. This affects only the brand name; the products and product numbers will remain unchanged. The brand transition is expected to be complete in or about May of 2024, and products shipping after that time will be branded Arrow.
- D. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.2 BUTT HINGES

- A. Hinges: ANSI/BHMA A156.1 butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.

1. Quantity: Provide the following hinge quantity:
 - a. Two Hinges: For doors with heights up to 60 inches.
 - b. Three Hinges: For doors with heights 61 to 90 inches.
 - c. Four Hinges: For doors with heights 91 to 120 inches.
 - d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
 - a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
 - b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.
3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
 - a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
 - b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
4. Hinge Options: Comply with the following:
 - a. Non-removable Pins: With the exception of electric through wire hinges, provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.
5. Manufacturers:
 - a. McKinney (MK) - TA/T4A Series, 5 knuckle.

2.3 POWER TRANSFER DEVICES

- A. Concealed Quick Connect Electric Power Transfers: Provide concealed wiring pathway housing mortised into the door and frame for low voltage electrified door hardware. Furnish with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Manufacturers:
 - a. Securitron (SU) - EL-CEPT Series.

- B. Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.

1. Provide one each of the following tools as part of the base bid contract:

- a. McKinney (MK) - Electrical Connecting Kit: QC-R001.
- b. McKinney (MK) - Connector Hand Tool: QC-R003.

2. Manufacturers:

- a. McKinney (MK) - QC-C Series.

2.4 CYLINDERS AND KEYING

- A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.

1. Manufacturers:

- a. Match Existing, Field Verify.

- B. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:

- 1. Threaded mortise cylinders with rings and cams to suit hardware application.
- 2. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
- 3. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.
- 4. Tubular deadlocks and other auxiliary locks.
- 5. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
- 6. Keyway: Manufacturer's Standard.

- C. Keying System: Each type of lock and cylinders to be factory keyed.

- 1. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.
- 2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.

3. Existing System: Field verify and key cylinders to match Owner's existing system.

D. Key Quantity: Provide the following minimum number of keys:

1. Change Keys per Cylinder: Two (2)
2. Master Keys (per Master Key Level/Group): Five (5).
3. Construction Keys (where required): Ten (10).

E. Construction Keying: Provide construction master keyed cylinders.

F. Key Registration List (Bitting List):

1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
2. Provide transcript list in writing or electronic file as directed by the Owner.

2.5 ELECTROMECHANICAL LOCKING DEVICES

A. Electromechanical Cylindrical Locksets, Grade 1 (Heavy Duty): Subject to same compliance standards and requirements as mechanical cylindrical locksets, electrified locksets to be of type and design as specified below.

1. Electrified Lock Options: Where indicated in the Hardware Sets, provide electrified options including: outside door lock/unlock trim control and request-to-exit signaling. Unless otherwise indicated, provide electrified locksets standard as fail secure.
2. Manufacturers:
 - a. Arrow, formerly known as Yale (YA) - 5400LN Series.

2.6 LOCK AND LATCH STRIKES

A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.

B. Standards: Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.
2. Strikes for Bored Locks and Latches: BHMA A156.2.
3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
4. Dustproof Strikes: BHMA A156.16.

2.7 DOOR CLOSERS

A. All door closers specified herein shall meet or exceed the following criteria:

1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.
2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.
4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
5. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
6. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.

B. Door Closers, Surface Mounted (Heavy Duty): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units standard..

1. Manufacturers:
 - a. Arrow, formerly known as Yale (YA) - 4400 Series.

2.8 ARCHITECTURAL TRIM

A. Door Protective Trim

1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1" LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.
3. Where plates are applied to fire rated doors with the top of the plate more than 16" above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer's catalog and template book for specific requirements for size and applications.
4. Protection Plates: ANSI/BHMA A156.6 protection plates (kick, armor, or mop), fabricated from the following:
 - a. Stainless Steel: 300 grade, 050-inch thick.
5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
6. Manufacturers:
 - a. Rockwood (RO).

2.9 ELECTRONIC ACCESSORIES

- A. Door Position Switches: Door position magnetic reed contact switches specifically designed for use in commercial door applications. On recessed models the contact and magnetic housing snap-lock into a 1" diameter hole. Surface mounted models include wide gap distance design complete with armored flex cabling. Provide SPDT, N/O switches with optional Rare Earth Magnet installation on steel doors with flush top channels.
1. Manufacturers:
 - a. Securitron (SU) - DPS Series.
- B. Intelligent Switching Power Supplies: Provide power supplies with single, dual or multi-voltage configurations at 12 and/or 24VDC. Power Supply shall have battery backup function with an integrated battery charging circuit. The power supply shall have a standard, integrated Fire Alarm Interface (FAI). The power supply shall provide

capability for secondary voltage, power distribution, direct lock control and network monitoring through add on modules. The power supply shall be expandable up to 16 individually protected outputs. Output modules shall provide individually protected, continuous outputs and/or individually protected, relay controlled outputs. Network modules shall provide remote monitoring functions such as status reporting, fault reporting and information logging.

1. Provide the least number of units, at the appropriate amperage level, sufficient to exceed the required total draw for the specified electrified hardware and access control equipment.
2. Manufacturers:
 - a. Securitron (SU) - AQL Series.

2.10 FABRICATION

- A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.11 FINISHES

- A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

- B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

- A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.
- B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

- A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
 - 1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.
- B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 2. DHI TDH-007-20: Installation Guide for Doors and Hardware.
 - 3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
 - 4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.
- C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
- D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."
- E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

- A. Field Inspection (Punch Report): Reference Division 01 Sections "Closeout Procedures". Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.
 - 1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.

3.5 ADJUSTING

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

3.6 CLEANING AND PROTECTION

- A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.
- B. Clean adjacent surfaces soiled by door hardware installation.
- C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

- A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 DOOR HARDWARE SETS

- A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted

items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

1. Quantities listed are for each pair of doors, or for each single door.
2. The supplier is responsible for handling and sizing all products.
3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.
4. At existing openings with new hardware the supplier shall field inspect existing conditions prior to the submittal stage to verify the specified hardware will work as required. Provide alternate solutions and proposals as needed.

B. Manufacturer's Abbreviations:

1. MK - McKinney
2. SU - Securitron
3. YA - Arrow, formerly known as Yale
4. RO - Rockwood

Hardware Sets

Set: 1.0

Doors: A101, A102

3 Hinge	T4A3786 [NRP]	US26D	MK	
1 Electric Power Transfer	EL-CEPT	630	SU	⚡
1 Fail Secure Lock	AU 5491LN REX	626	YA	⚡
1 Cylinder	As Required to Match Facility Standard			
1 Surface Closer	4420	689	YA	
1 Kick Plate	K1050 10" high CSK BEV	US32D	RO	
3 Silencer	608		RO	
1 Card Reader	Provided By Security Supplier			
1 ElectroLynx Harness	QC-C**** x Length Required		MK	⚡
1 ElectroLynx Harness	QC-C1500P		MK	⚡
1 Position Switch	DPS-M-BK		SU	⚡
1 Power Supply	AQL4-R8E1		SU	⚡

1 Wiring Diagram

Elevation and Point to Point as
Specified

Notes:

SYSTEM OPERATIONAL NARRATIVE

Door is normally closed and secure.

Presenting valid credential to wall mounted card reader temporarily unlocks lever allowing entry.

Entry also possible via key override.

Free egress at all times.

Request to exit switch, incorporated in lockset, signals an egress.

Door position switch monitors door open/closed status.

Lever remains locked during power loss. (Fail Secure)

END OF SECTION 087100

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. This Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
 - 1. Windows.
 - 2. Doors.
 - 3. Storefront framing.
 - 4. Glazed entrances.
 - 5. Interior Glazing Frames

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. 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. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

2. Review temporary protection requirements for glazing during and after installation.

1.6 ACTION SUBMITTALS

- A. Product Data: For each glass product and glazing material indicated.
- B. Glass Samples: For the following products, in the form of 12-inch- square Samples for glass.
 1. Insulating glass for each designation indicated.
- C. Glazing Accessory Samples: For gaskets, sealants, and colored spacers, in 12-inch lengths. Fire rated sealants.
- D. Glazing Schedule: Use same designations indicated on Drawings for glazed openings in preparing a schedule listing glass types and thicknesses for each size opening and location.
- 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 installers and manufacturers of insulating-glass units.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for insulating glass and glazing sealants.
 1. For glazing sealants, including fire rated glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.
- C. Preconstruction adhesion and compatibility test report.
- D. Warranties: Special warranties specified in this Section.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved and certified by coated-glass manufacturer.
- B. Preferred 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. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.

- C. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
- D. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Refer Division 08 Sections "Aluminum Framed Entrances and Storefronts" and "Glazed Aluminum Curtain Walls".
 - 2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 PRECONSTRUCTION TESTING

- A. Preconstruction Adhesion and Compatibility Testing: Test each glass product, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants. Ensure full aesthetic and functional compatibility of all materials.
 - 1. Testing is not required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.
 - 2. Use ASTM C 1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
 - 3. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
 - 4. Schedule enough time for testing and analyzing results to prevent delaying the Work.
 - 5. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.

1.10 DELIVERY, STORAGE, AND HANDLING

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

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.

1.12 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form in which coated-glass 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 on Insulating Glass: Manufacturer's standard form in which 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

- A. Basis-of-Design Products: Subject to compliance with requirements, provide Guardian Glass, LLC. glazing units, or comparable product by one of the following:
 1. AGC Glass.
 2. Viracon.
 3. Vitro (formerly known as PPG).
- B. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.
- 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: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

- B. Delegated Design: Design glass, including comprehensive engineering analysis according to ASTM E 1300 by a qualified professional engineer, using the following design criteria:
 - 1. Design Wind Pressures: As indicated on Drawings.
 - a. Wind Design Data: As indicated on Drawings.
 - 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, whichever is less, while maintaining an appropriate margin of safety against disengagement under all design conditions.
- C. Thermal Stress: Ensure that glazing can reliably withstand all design thermal exposure conditions without breakage.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
 - 1. Temperature Change (Range): 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.
- F. 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 laminated-glass lites, properties are based on products of construction indicated.
 - 3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
 - 4. U-Factors: Center-of-glazing values, according to NFRC 100 and based on most current edition of LBL's WINDOW computer program, expressed as Btu/sq. ft. x h x deg F (W/sq. m x K).
 - 5. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on most current edition of LBL's WINDOW computer program.
 - 6. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.3 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. NGA/GANA Publications: "Glazing Manual."
 2. FGIA/IGMA Publication for Insulating Glass: TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial & Residential Use."
- B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
- D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.
1. Minimum Glass Thickness for Exterior Lites: Not less than 6.0 mm.
- E. Strength: Where float glass is indicated, specifically provide annealed float glass, Kind HS heat-strengthened float glass, or Kind FT fully tempered float glass as needed to comply with "Performance Requirements" Article.

2.4 GLASS PRODUCTS

- A. Float Glass: ASTM C 1036, Type I, Quality-Q3, Class I (clear) unless otherwise indicated.
- B. Heat-Strengthened Float Glass: ASTM C 1048; Kind HS (heat-strengthened), Condition A (uncoated) unless otherwise indicated Type I, Class 1 (clear) or Class 2 (tinted) as indicated; Quality-Q3; Class I (clear) unless otherwise indicated; of kind and condition indicated.
1. For uncoated glass, comply with requirements for Condition A.
 2. For coated vision glass, comply with requirements for Condition C (other uncoated glass).
 3. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion horizontally oriented upon installation.
- C. Fully Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
1. For coated vision glass, comply with requirements for Condition C (other uncoated glass).
 2. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion horizontally oriented upon glazing installation.
- D. Translucent Glass: ASTM C 1048, Condition A, Type I, Quality-Q3, and complying with other requirements specified.

1. Basis-of-Design Product: Subject to compliance with requirements, provide the following:
 - a. Guardian, Inc.; SatinDeco, Acid Etched Translucent Glass.

2.5 INSULATING-GLASS UNITS

- A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190, and complying with other requirements specified.
 1. Sealing System: Dual seal, with manufacturer's standard primary and secondary.
 2. Spacer Specifications: Manufacturer's standard spacer material and construction.
- B. Glass: Comply with applicable requirements in "Glass Products" Article as indicated by designations in "Insulating-Glass Types" Article.

2.6 GLAZING SEALANTS

- A. General:
 1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
 3. 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, 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. May National Associates, Inc.; Bondaflex Sil 290.
 - d. Pecora Corporation; 890.
 - e. Sika Corporation, Construction Products Division; SikaSil-C990.
 - f. Tremco Incorporated; Spectrem 1.

2.7 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces;

with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:

1. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

2.8 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
- F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

2.9 GLAZING GASKETS

- A. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned EPDM, silicone, or thermoplastic polyolefin rubber gaskets complying with ASTM C 509, Type II, black; of profile and hardness required to maintain watertight seal.
 1. Application: Use where soft compression gaskets will be compressed by inserting dense compression gaskets on opposite side of glazing or pressure applied by means of pressure-glazing stops on opposite side of glazing.

2.10 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
 1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.

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 will 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. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.
- 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 as follows:
 - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
 - 2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- 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 in each series with uniform pattern, draw, bow, and similar characteristics.
- J. Set glass lites with proper orientation so that coatings face exterior or interior as specified.
- K. 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.
- L. 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 just before each glazing unit is installed.
- F. Apply heel bead of elastomeric sealant.

- G. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 CLEANING AND PROTECTION

- A. Immediately after installation remove non permanent 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 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 INSULATING-GLASS TYPES - SCHEDULE

- A. **Glass Type 1 (G1):** Low-E Coated, Clear Insulating Vision Glass. Guardian Glass, LLC; **SunGuard SN 68 on Clear (Drexel Hill MS Courtyard Elevations):**
 - 1. Overall Unit Thickness: 1 inch.
 - 2. Thickness of Each Glass Lite: 6mm (1/4 inch).
 - 3. Outboard Lite: Sputter-coated Clear float glass.
 - a. Coating on Surface No. 2: Guardian SunGuard, SuperNeutral 68.
 - b. Heat Treatment: Heat Strengthened.
 - 4. Interspace Content: Air filled, 12 mm (1/2 inch) wide, hermetically sealed.
 - 5. Inboard Lite: Clear float glass.
 - a. Heat Treatment: Heat Strengthened.
 - 6. Glass Unit Performance Characteristics:
 - a. Visible Light Transmittance: 68 percent minimum.
 - b. Solar Heat Gain Coefficient: 0.38 maximum.
 - c. Winter Nighttime U-Factor: 0.29 percent maximum.
 - d. Summer Daytime U-Factor: 0.28 maximum.
 - 7. Safety Glazing as required.
- B. **Glass Type Spandrel (S):** 1/4" Monolithic Glazing, Tempered Spandrel.
 - 1. Color Selection: Select Spandrel Color from Manufacturers standard selection of spandrel colors.

END OF SECTION 088000

SECTION 088733 – DECORATIVE FILMS

PART 1 - GENERAL

1.1 CONDITIONS AND REQUIREMENTS

- A. The General Conditions, Supplementary Conditions, and Division 01 – General Requirements apply.

1.2 SECTION INCLUDES

- A. Decorative films.

1.3 RELATED SECTIONS

- A. Section 088000 - Glazing: Substrate for application of decorative film.

1.4 REFERENCES

- A. ASTM International (ASTM):
 1. ASTM D882 - Standard Test Method for Tensile Properties of Thin Plastic Sheeting.
 2. ASTM D1044 - Test for Resistance of Transparent Plastics to Surface Abrasion (Taber Abrader Test).
 3. ASTM D4830 - Standard Test Methods for Characterizing Thermoplastic Fabrics Used in Roofing and Waterproofing. Section 7: Puncture Strength.
 4. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
 5. ASTM E903 - Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres.

1.5 DEFINITIONS

- A. Pattern Series Films: These films are scratch-resistant and offer a wide range of aesthetic solutions through varying levels of translucent and opaque whites with a simulated acid-etched appearance. These films also include a broad range of classic patterns.

1.6 PERFORMANCE REQUIREMENTS

- A. Surface Burning Characteristics: Provide films that have Flame Spread Index of 0 and Smoke Developed Index of 30 or less when tested in accordance with ASTM E84.
- B. Provide decorative films that do not have a masking sheet.

1.7 SUBMITTALS

- A. Product Data: Submit for each product specified indicating:
 - 1. Performance properties.
 - 2. Preparation and installation instructions and recommendations.
 - 3. Storage and handling recommendations.
- B. Samples: For each type of decorative film specified, two (2) samples, 12 inches square.
- C. Qualification Data: Submit documentation indicating qualifications of decorative film manufacturer.
- D. Operation and Maintenance Data: Submit for decorative film to include in maintenance manuals.
- E. Warranty: Submit sample special warranty specified in this section.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that has a minimum of 10 years of documented experience manufacturing decorative films similar to that used for this project.
- B. Installer Qualifications: A firm that is authorized by decorative film manufacturer to install film in accordance with guidelines set forth by the manufacturer.
- C. Source Limitations: Obtain each type of decorative film from same manufacturer.
- D. Mockups: Build mockups to verify selections made under sample submittals and to evaluate surface preparation techniques and application workmanship.
 - 1. Construct mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
 - 2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- E. Preinstallation Conference: Conduct conference at project site to discuss methods and procedures relating to installation of the decorative films.

1.9 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, and handle materials in manufacturer's protective packaging.
- B. Store and protect materials according to manufacturer's written recommendations to prevent damage from condensation, temperature changes, direct exposure to sun, or other causes.

1.10 SITE CONDITIONS

- A. Ambient Conditions: Maintain temperature, humidity, and ventilation within limits recommended by manufacturer.

1.11 WARRANTY

- A. Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to replace films that fail within specified warranty period.
 - 1. Warranty Period: 10 years from date of original installation.
 - 2. Warranty coverage limited to owner of property at time of installation.
 - 3. Manufacturer's obligation is limited to furnishing replacement film for any film covered by limited warranty which manufacturer determines to be defective. Manufacturer will not be liable for installation costs of replacement film or for any special, indirect, incidental or consequential damages.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: The design for decorative films is based on LLumar Decorative Series Films manufactured by Solutia Inc. Performance Films Division; or approved equal including but not limited to:
 - 1. 3M FASARA - Illumina.

2.2 DECORATIVE FILMS

- A. Type A Window Film: Decorative Film: LLumar Matte Frost Series Decorative Film – Dusted Frost - with the following performance characteristics when applied to the interior surface of double-pane, 1 inch insulated glazing units:
 - 1. Visible Light Transmission: 57%.
 - 2. Diffuse Visible Light Reflectance: 30 percent.
 - 3. Privacy Film Rating: 1-8.

4. Film Thickness without liner: 0.002 inches.
5. Film Color: to be selected from manufacturer's full range of colors.

2.3 DECORATIVE FILM ACCESSORIES

- A. General: Provide accessories either manufactured by or acceptable to decorative film manufacturer for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Adhesive: Pressure sensitive acrylic adhesive system.
- C. Cleaners, Primers, and Sealers: Types recommended by decorative film manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates for compliance with requirements and for conditions affecting performance of decorative film including glass that is broken, chipped, cracked, abraded, or damaged in any way.
- B. 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 thoroughly prior to installation.
- C. Prepare substrates using methods recommended by decorative film manufacturer to achieve the best results for the substrate under project conditions.
- D. Protect window frames and surrounding surfaces to prevent damage during installation.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's written instructions.
- B. Install film continuously, but not necessarily in one (1) continuous length. Install with no gaps or overlaps. Make seams non-overlapping.
- C. Do not remove release liner from film until just before each piece of film is cut and ready for installation.

- D. Install film with mounting solution and custom cut to the glass with neat, square corners and edges to within 1/8-inch of window frame.
- E. Remove air bubbles, blisters, and other defects. Be careful to remove “fingers” to eliminate any contamination or excess water pockets. It is crucial to remove as much water as possible during installation.
- F. A final squeegee pass over the entire pane using a Blue Max Blade with an extended handle design (or Thor’s Hammer) is recommended.

3.4 FIELD QUALITY CONTROL

- A. After installation, view film from a distance of 10 feet against a bright uniform sky or background. Film shall appear uniform in appearance with no visible streaks, wrinkles, banding, thin spots or pinholes.
- B. If installed film does not meet these criteria, remove and replace with new film.

3.5 CLEANING AND PROTECTION

- A. Remove excess mounting solution at finished seams, perimeter edges, and adjacent surfaces.
- B. Use cleaning methods recommended by decorative film manufacturer.
- C. Replace films that cannot be cleaned.
- D. Protect installed products until completion of project.
- E. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 088733

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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 and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Non-load-bearing steel framing systems for interior gypsum board assemblies.
 - 2. Suspension systems for interior gypsum ceilings, soffits, and grid systems.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For dimpled steel studs and runners, and firestop tracks, from ICC-ES.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

2.2 FRAMING SYSTEMS

- A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
 - 1. Manufacturers:

- a. Marino Ware
 - b. CEMCO
 - c. ClarkDietrich
 2. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
 3. Protective Coating: ASTM A 653/A 653M, G40, hot-dip galvanized unless otherwise indicated.
- B. Studs and Runners: ASTM C 645. Use either steel studs and runners or dimpled steel studs and runners.
1. Steel Studs and Runners:
 - a. Minimum Base-Metal Thickness: Per UL Design Standards, or indicated on Drawings. (20 Gauge)
 - b. Depth: As indicated on Drawings.
 2. Dimpled Steel Studs and Runners:
 - a. Minimum Base-Metal Thickness: Per UL Design Standards, or indicated on Drawings. (20 Gauge)
 - b. Depth: As indicated on Drawings.
- C. 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, available products that may be incorporated into the Work from manufacturers listed above.
- D. 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. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Fire Trak Corp.; Fire Trak System.

- b. Grace Construction Products; FlameSafe FlowTrak System.
 - c. Metal-Lite, Inc.; The System.
- E. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
- 1. Minimum Base-Metal Thickness: Per UL Design Standards, or indicated on Drawings.
- F. Cold-Rolled Channel Bridging: Steel, 0.053-inch minimum base-metal thickness, with minimum 1/2-inch- wide flanges.
- 1. Depth: As indicated on Drawings.
 - 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch- thick, galvanized steel.
- G. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
- 1. Minimum Base-Metal Thickness: Per UL Design Standards, or indicated on Drawings.
 - 2. Depth: As indicated on Drawings.
- H. Resilient Furring Channels: 1/2-inch- deep, steel sheet members designed to reduce sound transmission.
- 1. Configuration: Asymmetrical or hat shaped.
- I. Cold-Rolled Furring Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch- wide flanges.
- 1. Depth: As indicated on Drawings.
 - 2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum uncoated-steel thickness of 0.033 inch.
 - 3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.
- J. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum uncoated-metal thickness of 0.018 inch, and depth required to fit insulation thickness indicated.

2.3 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.
- 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, or 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, 0.16 inch in diameter.
- D. Flat Hangers: Steel sheet, in size indicated on Drawings.
- E. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.053 inch and minimum 1/2-inch- wide flanges.
 1. Depth: As indicated on Drawings.
- F. Furring Channels (Furring Members):
 1. Cold-Rolled Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch- wide flanges, 3/4 inch deep.
 2. Steel Studs and Runners: ASTM C 645.
 - a. Minimum Base-Metal Thickness: Per UL Design Standards, or indicated on Drawings.
 - b. Depth: As indicated on Drawings.
 3. Dimpled Steel Studs and Runners: ASTM C 645.
 - a. Minimum Base-Metal Thickness: Per UL Design Standards, or indicated on Drawings.
 - b. Depth: As indicated on Drawings.
 4. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.
 - a. Minimum Base-Metal Thickness: Per UL Design Standards, or indicated on Drawings.
 5. Resilient Furring Channels: 1/2-inch- deep members designed to reduce sound transmission.
 - a. Configuration: Asymmetrical or hat shaped.
- G. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.

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. Armstrong World Industries, Inc.; Drywall Grid Systems.
 - b. Chicago Metallic Corporation; Drywall Grid System.
 - c. USG Corporation; Drywall Suspension System.

2.4 AUXILIARY MATERIALS

- A. 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.
- B. Isolation Strip at Exterior Walls: Provide one of the following:
 1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.
 2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.
- B. Coordination with Sprayed Fire-Resistive Materials:
 1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed fire-resistive

materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches o.c.

2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.3 INSTALLATION, GENERAL

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

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- C. Install studs so flanges within framing system point in same direction.
- D. Install tracks (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.
- 5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
- 6. Curved Partitions:
 - a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
 - b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches o.c.
- E. Direct Furring:
 - 1. Screw to wood framing.
 - 2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
- F. Z-Furring Members:
 - 1. Erect insulation, specified in Section 072100 "Thermal 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.
- G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.5 INSTALLING SUSPENSION SYSTEMS

- A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
 - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
 - 3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 - 4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 - 5. Do not attach hangers to steel roof deck.
 - 6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
 - 7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
 - 8. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.
- F. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
- G. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 092216

SECTION 092600 - GYPSUM VENEER PLASTERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Gypsum veneer plaster for patching of existing plaster walls and ceilings.

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain gypsum veneer plaster products, including joint reinforcing tape, and embedding material, from a single manufacturer.
- B. Fire-Resistance-Rated Assemblies: Provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by a testing and inspecting agency.
- C. 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 a testing and inspecting agency.
- D. Mockups: Provide a full-thickness finish mockup of gypsum veneer plaster and substrate to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Provide mockups of ceilings and partitions in sizes of at least 4 sq. ft.
 - 2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages, containers, and bundles bearing brand name and identification of manufacturer or supplier.
- B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 843 requirements or gypsum veneer plaster manufacturer's written recommendations, whichever are more stringent.
- B. Room Temperatures: Maintain not less than 55 deg F or more than 80 deg F for 7 days before application of gypsum veneer plaster, continuously during application, and after application until veneer plaster is dry.
- C. Avoid conditions that result in gypsum veneer plaster drying too rapidly.
 - 1. Distribute heat evenly; prevent concentrated or uneven heat on veneer plaster.
 - 2. Maintain relative humidity levels, for prevailing ambient temperature, that produce normal drying conditions.
 - 3. Ventilate building spaces in a manner that prevents drafts of air from contacting surfaces during veneer plaster application until it is dry.

PART 2 - PRODUCTS

- 2.1 INSTALLER: Basis of Design has visited the schools and is familiar with the scope of work:

PAULS PLASTERING
Www.paulsplastering.com
19 Davidson Lane
New Castle, DE 19720

Off: 302-654-5583
Fax: 302-656-2582

- A. Or Certified Approved Equal.

2.2 GYPSUM VENEER PLASTER MATERIALS

- A. High-Strength, One-Component Gypsum Veneer Plaster: ASTM C 587, ready-mixed, smooth, finish-coat veneer plaster containing mill-mixed, fine silica sand; with a compressive strength of 3000 psi when tested according to ASTM C 472; and formulated for application directly over substrate without use of separate base-coat material.
 - 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. USG Corporation; Imperial Finish Plaster.

2.3 TRIM ACCESSORIES

- A. Standard Trim: ASTM C 1047, provided or approved by manufacturer for use in gypsum veneer plaster applications indicated.
 - 1. Material: Galvanized or aluminum-coated 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. Curved-Edge Cornerbead: With notched or flexible flanges.
 - g. Control joints.

2.4 JOINT REINFORCING MATERIALS

- A. General: Comply with joint strength requirements in ASTM C 587 and with gypsum veneer plaster manufacturer's written recommendations for each application indicated.
- B. Joint Tape:
 - 1. Gypsum Base for Veneer Plaster: As recommended by gypsum veneer plaster manufacturer for applications indicated.

2.5 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced product standards and manufacturer's written recommendations.
- B. Bonding Agent: ASTM C 631, polyvinyl acetate.
- C. Laminating Adhesive: Adhesive or joint compound recommended by manufacturer for directly adhering gypsum base face-layer panels to backing-layer panels in multilayer construction.
 - 1. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
 - 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
- E. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- F. Acoustical Sealant: As specified in Division 7 Section "Joint Sealants."
- G. Patching Mortar: Dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

2.6 GYPSUM VENEER PLASTER MIXES

- A. Mechanically mix gypsum veneer plaster materials to comply with ASTM C 843 and with gypsum veneer plaster manufacturer's written recommendations.

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.
- B. Examine existing conditions before installation. Reject existing conditions that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Monolithic Concrete Substrates: Prepare according to gypsum veneer plaster manufacturer's written recommendations and as follows:
 - 1. Clean surfaces to remove dust, loose particles, grease, oil, incompatible curing compounds, form-release agents, and other foreign matter and deposits that could impair bond with gypsum veneer plaster.
 - 2. Remove ridges and protrusions greater than 1/8 inch and fill depressions greater than 1/4 inch with patching mortar. Allow to set and dry.
 - 3. Apply bonding agent on dry and cured concrete substrates.
- B. Masonry Substrates: Prepare according to gypsum veneer plaster manufacturer's written recommendations and as follows:
 - 1. Clean surfaces to remove dirt, grease, oil, and other foreign matter and deposits that could impair bond with gypsum veneer plaster.
 - 2. Apply bonding agent on dry masonry substrates.

3.3 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install according to ASTM C 844 and in specific locations approved by Architect.

3.4 INSTALLING JOINT REINFORCEMENT

- A. Gypsum Base for Veneer Plaster: Reinforce interior angles and flat joints with joint tape and embedding material to comply with ASTM C 843 and with gypsum veneer plaster manufacturer's written recommendations.
- B. Abuse-Resistant Base: Reinforce joints between abuse-resistant panels with joint tape and embedding material according to panel manufacturer's written recommendations.
- C. Impact-Resistant Base: Reinforce joints between impact-resistant panels with joint tape and embedding material according to panel manufacturer's written recommendations.
- D. Moisture- and Mold-Resistant Base: Reinforce joints between moisture- and mold-resistant panels with joint tape and embedding material according to panel manufacturer's written recommendations.

- E. Cementitious Backer Units: Reinforce joints between cementitious backer units with joint tape and embedding material according to unit manufacturer's written recommendations.

3.5 GYPSUM VENEER PLASTERING

- A. Bonding Agent: Apply bonding agent on dry existing substrate according to gypsum veneer plaster manufacturer's written recommendations.
- B. Gypsum Veneer Plaster Application: Comply with ASTM C 843 and with veneer plaster manufacturer's written recommendations.
 - 1. One-Component Gypsum Veneer Plaster: Trowel apply base coat over substrate to uniform thickness of 1/16 to 3/32 inch. Fill all voids and imperfections. Allow plaster to set, then scratch and immediately double back with gypsum veneer plaster to uniform total thickness of 3/16 inch.
 - 2. Where gypsum veneer plaster abuts only metal door frames, windows, and other units, groove finish coat to eliminate spalling.
 - 3. Do not apply veneer plaster to gypsum base if paper facing has degraded from exposure to sunlight. Before applying veneer plaster, use remedial methods to restore bonding capability to degraded paper facing according to manufacturer's written recommendations.
- C. Gypsum Veneer Plaster Finish: Smooth-troweled finish.

3.6 PROTECTION

- A. Protect installed gypsum veneer plaster from damage from weather, condensation, construction, and other causes during remainder of the construction period.
- B. Remove and replace gypsum veneer plaster that is wet, moisture damaged, or mold damaged.

END OF SECTION 092600

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Interior gypsum board.
 - 2. Tile backing panels.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For the following products:
 - 1. Trim Accessories: 12-inch long samples of each trim accessory indicated.

1.4 DELIVERY, STORAGE, AND HANDLING

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

1.5 FIELD CONDITIONS

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

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 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 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.

2.2 GYPSUM BOARD, GENERAL

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

2.3 INTERIOR GYPSUM BOARD

- A. Basis of Design Product: Subject to compliance with requirements, provide products as manufactured by USG Corporation, or comparable product by one of the following:
 1. CertainTeed Corp.
 2. Georgia-Pacific Gypsum LLC.
- B. Gypsum Wallboard: ASTM C 1396/C 1396M.
 1. Thickness: As indicated
 2. Long Edges: Tapered.
- C. Gypsum Board, Type X: ASTM C 1396/C 1396M.
 1. Thickness: As indicated
 2. Long Edges: Tapered.
- D. Gypsum Ceiling Board: ASTM C 1396/C 1396M.
 1. Thickness: 1/2 inch.
 2. Long Edges: Tapered.
- E. Abuse-Resistant Gypsum Board: ASTM C 1629/C 1629M, Level 3 – Impact Resistant.

1. Core: Fiberglass mesh, 5/8 inch, Type X.
2. Long Edges: Tapered.
3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

F. Moisture- and Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.

1. Core: 5/8 inch, Type X.
2. Long Edges: Tapered.

2.4 SPECIALTY GYPSUM BOARD

A. Gypsum Board, Type C: ASTM C 1396/C 1396M. Manufactured to have increased fire-resistive capability.

1. Basis of Design Product: Subject to compliance with requirements, provide USG Corporation; Firecode C Core, or comparable product by one of the following:
 - a. CertainTeed Corp.; ProRoc Type C.
 - b. Georgia-Pacific Gypsum LLC; Fireguard C.
2. Thickness: As required by fire-resistance-rated assembly indicated on Drawings.
3. Long Edges: Tapered.

2.5 TILE BACKING PANELS

A. Cementitious Backer Units: ANSI A118.9 and ASTM C 1288 or 1325, with manufacturer's standard edges.

1. Basis of Design Product: Subject to compliance with requirements, provide USG Corporation; DUROCK Cement Board, or comparable product by one of the following:
 - a. CertainTeed Corp.; FiberCement BackerBoard.
 - b. Georgia-Pacific Gypsum LLC
2. Thickness: As indicated on Drawings.
3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.6 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet.

2. Shapes:

- a. Cornerbead.

B. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Fry Reglet Corp., DRM-625-100 (Basis of Design)
 - b. Gordon, Inc.
 - c. Pittcon Industries.
2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221, Alloy 6063-T5.
3. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

C. Edge Trim (at gypsum board ceiling locations)

Acceptable manufacturers:

- a. Armstrong : Axiom Classic
- b. Certainteed : Cloud Perimeter Trim
- c. USG: Compasso
- d. Rockfon (formerly Chicago Metallic): Infinity R Perimeter Trim

2.7 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:

1. Interior Gypsum Wallboard: Paper.
2. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints, 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.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
3. Fill Coat: For second coat, use drying-type, all-purpose compound.

4. Finish Coat: For third coat, use drying-type, all-purpose compound.
- D. Joint Compound for Tile Backing Panels:
 1. Cementitious Backer Units: As recommended by backer unit manufacturer.

2.8 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
- C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
 1. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- D. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
- E. Acoustical Sealant: As specified in Section 079200 "Joint Sealants."
- F. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."
- G. Isolation Strip at Exterior Walls: Provide one of the following:
 1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.
 2. 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 and framing, for compliance with requirements and other conditions affecting performance.

- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch 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, except floors. 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 C 919 and with manufacturer's written recommendations 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 APPLYING INTERIOR GYPSUM BOARD

A. 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-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.

B. 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 1 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-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.

- C. 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 recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.
- D. Curved Surfaces:
 - 1. Install panels horizontally (perpendicular to supports) and unbroken, to extent possible, across curved surface plus 12-inch-long straight sections at ends of curves and tangent to them.
 - 2. For double-layer construction, fasten base layer to studs with screws 16 inches o.c. Center gypsum board face layer over joints in base layer, and fasten to studs with screws spaced 12 inches o.c.

3.4 APPLYING TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A108.11, at showers, tubs, and where indicated.
- B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.5 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.
- C. Interior Trim: Install in the following locations:
 - 1. Cornerbead: Use at outside corners, unless otherwise indicated.
- D. Aluminum Trim: Install in locations indicated on Drawings.

3.6 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints, rounded or beveled edges, and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 2: Where indicated on Drawings.
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.

a. Primer and its application to surfaces are specified in other Division 09 Painting Sections.

E. Cementitious Backer Units: Finish according to manufacturer's written instructions.

F. Maximum variation of finished gypsum board surface from true flatness: 1/8 inch in 10 feet in any direction.

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 092900

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SECTION 093013 - CERAMIC TILING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Porcelain tile.
2. Ceramic tile.
3. Stone thresholds.
4. Waterproof membrane.
5. Crack isolation membrane.
6. Cementitious backer units installed as part of tile installations.

1.3 DEFINITIONS

- A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
- B. Module Size: Actual tile size plus joint width indicated.
- C. Face Size: Actual tile size, excluding spacer lugs.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.

1.5 ACTION SUBMITTALS

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

- 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 each type of tile and grout indicated. Include samples of 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 4 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 for each color and finish required.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified 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, signed by product manufacturer.
- D. Product Test Reports: For each tile-setting and -grouting product.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.
 - 2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer is a five-star member of the National Tile Contractors Association.

2. Installer employs Ceramic Tile Education Foundation Certified Installers or installers recognized by the U.S. Department of Labor as Journeyman Tile Layers.
- 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 wall tile installation.
 2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
- D. Store liquid materials in unopened containers and protected from freezing.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
 1. Provide tile complying with Standard grade requirements unless otherwise indicated.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCA 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.
- E. Factory-Applied Temporary Protective Coating: Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by precoating with continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

2.2 TILE PRODUCTS

- A. Porcelain Tile: Refer to Finish Schedule on the Drawings for manufacturers, products, sizes, and colors.
 - 1. Grout Color: As selected by Architect from manufacturer's full range.
 - 2. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as indicated on Drawings.
 - 3. Source Limitations: Obtain tile from single source unless otherwise directed by finish schedule.
- B. Ceramic Tile: Refer to Finish Schedule on the Drawings for manufacturers, products, sizes, and colors.
 - 1. Grout Color: As selected by Architect from manufacturer's full range.
 - 2. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as indicated on Drawings.
 - 3. Source Limitations: Obtain tile from single source unless otherwise directed by finish schedule.

2.3 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 C 503/C 503M, with a minimum abrasion resistance of 10 according to ASTM C 1353 or ASTM C 241/C 241M and with honed finish.

- 1. Description: Uniform, fine- to medium-grained white stone with gray veining.

2.4 WATERPROOF MEMBRANE

- A. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

- B. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and continuous fabric reinforcement.

- 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. Custom Building Products; 9240 Waterproofing and Anti-Fracture Membrane.
 - b. Laticrete International, Inc.; Laticrete 9235 Waterproof Membrane.
 - c. MAPEI Corporation; Mapelastic 400.

- C. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.

- 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. Custom Building Products; RedGard Waterproofing and Crack Prevention Membrane.
 - b. Laticrete International, Inc.; Laticrete Hydro Ban.
 - c. MAPEI Corporation; Mapelastic AquaDefense.

- D. Locations: Install waterproofing membrane under entire areas of ceramic tile floors and walls in all toilet room locations.

2.5 CRACK ISOLATION MEMBRANE

- A. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.12, and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

- B. Locations: Install crack isolation membrane under entire areas of ceramic tile floors.

- C. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and fabric reinforcement.

- 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. Custom Building Products; 9240 Waterproofing and Anti-Fracture Membrane.
 - b. Laticrete International, Inc.; Laticrete Blue 92 Anti-Fracture Membrane.
 - c. MAPEI Corporation; Mapelastic HPG with MAPEI Fiberglass Mesh.
- D. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.
- 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. Custom Building Products; RedGard Waterproofing and Crack Prevention Membrane.
 - b. Laticrete International, Inc.; Laticrete Hydro Ban.
 - c. MAPEI Corporation; Mapelastic AquaDefense.

2.6 SETTING MATERIALS

- A. Dry-Set Portland Cement Mortar (Thin Set): ANSI A118.1.
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Custom Building Products.
 - b. Laticrete International, Inc.
 - c. MAPEI Corporation.
 - 2. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.1.
- B. Latex-Portland Cement Mortar (Thin Set): ANSI A118.4.
- 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. Custom Building Products.
 - b. Laticrete International, Inc.
 - c. MAPEI Corporation.
 - 2. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.
- C. Improved Modified Dry-Set Latex-Portland Cement Mortar (LHT) Medium Bed: ANSI A118.4 and / or ANSI 118.15.
- 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. Custom Building Products.
 - a. Laticrete International, Inc.
 - b. MAPEI Corporation.
2. For tiles over 15" for both wall and floor applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4 and/ or ANSI 118.15.

2.7 GROUT MATERIALS

- A. Sand-Portland Cement Grout: ANSI A108.10, composed of white or gray cement and white or colored aggregate as required to produce color indicated.
- B. Standard Cement Grout: ANSI A118.6.
 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. Custom Building Products.
 - b. Laticrete International, Inc.
 - c. MAPEI Corporation.
- C. Polymer-Modified Tile Grout: ANSI A118.7.
 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. Custom Building Products.
 - b. Laticrete International, Inc.
 - c. MAPEI Corporation.
 2. Locations:
 - a. High traffic floor areas for thinset applications.
 - b. Patching and repair work.

2.8 MISCELLANEOUS MATERIALS

- A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
- B. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

- C. Grout Sealer: Manufacturer's standard product for sealing grout joints and that does not change color or appearance of grout.
 - 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. Custom Building Products; Grout and Tile Sealer.
 - b. MAPEI Corporation; KER 004, Keraseal Penetrating Sealer for Unglazed Grout and Tile.

2.9 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 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.
- B. Where indicated, prepare substrates to receive waterproofing 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 TILE INSTALLATION

- A. Comply with the TCNA "Handbook for Ceramic, Glass, and Stone Tile Installation" for 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. Tile floors in wet areas.
 - b. Tile floors in laundries.
 - c. Tile floors consisting of tiles 8 by 8 inches or larger.
 - d. 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. 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 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 walls, or trim, align joints unless otherwise indicated.
- F. Joint Widths: As indicated.
- G. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.
- H. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
- I. 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 latex-portland cement mortar (thinset).
 2. Do not extend waterproofing or crack isolation membrane under thresholds set in dry-set portland cement or latex-portland cement mortar. Fill joints between such thresholds and adjoining tile set on waterproofing or crack isolation membrane with elastomeric sealant.
- J. Grout Sealer: Apply grout sealer to grout joints in tile floors according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.4 WATERPROOFING INSTALLATION

- A. Install waterproofing 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 waterproofing to cure and verify by testing that it is watertight before installing tile or setting materials over it.

3.5 CRACK ISOLATION MEMBRANE INSTALLATION

- 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.

3.6 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. Remove temporary protective coating by method recommended by coating manufacturer and that is acceptable to tile and grout manufacturer. Trap and remove coating to prevent drain clogging.

3.7 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.

3.8 INTERIOR TILE INSTALLATION SCHEDULE

- A. Interior Floor Installations, Concrete Subfloor:
 - 1. Tile Installation F205: Cementitious Self Leveling and optional membrane over concrete.

- a. Tile Type: N/A
- b. Thin-Set Mortar: (tiles under 15") LHT / Medium-bed (tiles over 15") dry-set portland cement mortar.
- c. Grout: ANSI 118.3 Epoxy Grout.
- d. Joint width: 1/8 inch.
2. Tile Installation F122 / F122A: Waterproof Membrane over concrete.
 - a. Tile Type: N/A
 - b. Thin-Set Mortar: (tiles under 15") LHT / Medium-bed (tiles over 15") dry-set portland cement mortar.
 - c. Grout: ANSI 118.3 Epoxy Grout.
 - d. Joint width: 1/8 inch.
3. Tile Installation F113 / F113A: Ceramic Tile over concrete on grade or above grade-Optional membrane.
 - a. Tile Type: N/A
 - b. Thin-Set Mortar: (tiles under 15") LHT / Medium-bed (tiles over 15") dry-set portland cement mortar.
 - c. Grout: ANSI 118.3 Epoxy Grout.
 - d. Joint width: 1/8 inch.
4. Tile Installation F111: Optional Unbonded Mortar Bed over concrete.
 - a. Tile Type: N/A
 - b. Thin-Set Mortar: (tiles under 15") LHT / Medium-bed (tiles over 15") dry-set portland cement mortar.
 - c. Grout: Chemical resistant, water-cleanable tile setting and grouting epoxy.
 - d. Joint width: 3/16 inch.

END OF SECTION 093013

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 ceilings.
- B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.3 PREINSTALLATION MEETINGS

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

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 Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.
 - 1. Acoustical Panel: Set of 6-inch- square Samples of each type, color, pattern, and texture.
 - 2. Exposed Suspension-System Members, Moldings, and Trim: Set of 6-inch- long Samples of each type, finish, and color.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Suspended ceiling components.

2. Structural members to which suspension systems will be attached.
3. Size and location of initial access modules for acoustical panels.
4. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
5. Perimeter moldings.

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 that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Acoustical Ceiling Panels: Full-size panels equal to 2 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.
4. Impact Clips: Equal to 2 percent of quantity installed.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to NVLAP for testing indicated.

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 typical ceiling area 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.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension-system components, and accessories to Project site in original, unopened packages 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.
- C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, 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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Acoustical ceiling shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
- C. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 ACOUSTICAL PANELS, GENERAL

- A. Source Limitations:

1. Acoustical Ceiling Panel: Obtain each type from single source from single manufacturer.
 2. Suspension System: Obtain each type from single source from single manufacturer.
- B. Source Limitations: Obtain each type of acoustical ceiling panel and supporting suspension system from single source from single manufacturer.
- C. Glass-Fiber-Based Panels: Made with binder containing no urea formaldehyde.
- D. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances unless otherwise indicated.
1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface according to ASTM E 795.
- E. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.
1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.
- F.** Manufacturer: Armstrong Commercial Ceilings (Basis-of-Design), or comparable products from USG Ceilings or Certainteed Ceilings.

2.3 ACOUSTICAL PANELS

- A. Refer to Finish Schedule on Drawings for manufacturers and products.
- B. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

2.4 METAL SUSPENSION SYSTEMS, GENERAL

- A. Metal Suspension-System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M.

- B. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
 2. 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 hangers of type indicated and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E 1190, conducted by a qualified testing and inspecting agency.
- C. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- diameter wire.
- D. Angle Hangers: Angles with legs not less than 7/8 inch wide; formed with 0.04-inch-thick, galvanized-steel sheet complying with ASTM A 653/A 653M, G90 coating designation; with bolted connections and 5/16-inch- diameter bolts.
- E. Stabilizer Bars: Manufacturer's standard perimeter stabilizers.

2.5 METAL SUSPENSION SYSTEM

- A. Refer to Finish Schedule on Drawings for manufacturers and products:

2.6 METAL EDGE MOLDINGS AND TRIM

1. Manufacturers: Provide moldings and trim by manufacturers indicated as Basis of Design in this specification.
- 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. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that 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.
- C. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements and the following:
1. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of 1.5 mils. Comply with ASTM C 635/C 635M and coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

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, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION

- A. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
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 and, if permitted with fire-resistance-rated ceilings, to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
 6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 8. Do not attach hangers to steel deck tabs.
 9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 10. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
 11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- C. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
1. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
 2. Do not use exposed fasteners, including pop rivets, on moldings and trim unless approved by Architect.
- D. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

- E. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
1. Arrange directionally patterned acoustical panels as follows:
 - a. As indicated on reflected ceiling plans.
 2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
 3. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
 4. 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.
 5. Install hold-down or impact clips in areas indicated, in areas required by authorities having jurisdiction, and for fire-resistance ratings; space as recommended by panel manufacturer's written instructions unless otherwise indicated.
 6. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

3.4 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. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

SECTION 096466.1 - WOOD FLOORING REFINISHING

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 Refinishing of existing Stage Wood Flooring.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for wood flooring.
- B. Samples for Verification: Include Sample sets showing finishes and game-line and marker paint colors applied to existing wood flooring.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For wood flooring finish systems to be included in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced Installer who has completed wood athletic flooring installations similar in material, design, and extent to that indicated for this Project and whose work has resulted in installations with a record of successful in-service performance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Bona Sport Finishing Products as manufactured by Bona US or approved equivalent.

2.2 FINISHES

- A. Floor-Finish System: MFMA approved.
 - 1. Floor-Sealer Formulation: Pliable, penetrating type. MFMA Group 1, Sealers.
 - 2. Finish-Coat Formulation: Formulated for gloss finish indicated and multi-coat application.

PART 3 - EXECUTION

3.1 SANDING AND FINISHING

- A. Follow applicable recommendations in MFMA's "Industry Recommendations for Sanding, Sealing, wood floors.
- B. Machine sand with coarse, medium, and fine grades of sandpaper to achieve a level, smooth, uniform surface without ridges or cups. Remove sanding dust by tack or vacuum.
- C. Finish: Apply seal and finish coats of finish system according to finish manufacturer's written instructions. Provide no fewer than four coats total and no fewer than two finish coats.

3.2 PROTECTION

- A. Protect wood flooring during remainder of construction period to allow finish to cure and to ensure that flooring and finish are without damage or deterioration at time of Substantial Completion.
 - 1. Do not cover flooring after finishing until finish reaches full cure and not before seven days after applying last finish coat.
 - 2. Do not move heavy and sharp objects directly over flooring. Protect fully cured floor finishes and surfaces with plywood or hardboard panels to prevent damage from storing or moving objects over flooring.

END OF SECTION 096466

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 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.
- C. Product Schedule: For resilient base and accessory products. Use same designations indicated on Drawings.

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. 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 and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Coordinate mockups in this Section with mockups specified in other Sections.

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 time periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 RESILIENT BASE

- A. Refer to Finish Schedule on Drawings for manufacturers, products, colors, and finishes.
- B. Lengths: Coils in manufacturer's standard length.
- C. Outside Corners: Job formed.
- D. Inside Corners: Job formed.

2.2 RESILIENT MOLDING ACCESSORY

- A. Refer to Finish Schedule on Drawings for manufacturers, products, colors, and finishes.

2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.
- C. Stair-Tread Nose Filler: Two-part epoxy compound recommended by resilient stair-tread manufacturer to fill nosing substrates that do not conform to tread contours.

EXECUTION

2.4 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.

2.5 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates for Resilient Stair Accessories: Prepare horizontal surfaces according to ASTM F 710.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
 - 3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.

4. Moisture Testing: Proceed with installation only after substrates pass testing according to manufacturer's written recommendations, but not less stringent than the following:
 - a. Perform anhydrous calcium chloride test according to ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
 - b. Perform relative humidity test using in situ probes according to ASTM F 2170. Proceed with installation only after substrates have maximum 75 percent relative humidity level.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install resilient products until they are the same temperature as the 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.

2.6 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. Job-Formed Corners:
 1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
 - a. Form without producing discoloration (whitening) at bends.

2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
 - a. Cope corners to minimize open joints.

2.7 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.

2.8 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 exposed surfaces.
- 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 096513

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SECTION 096519.53 – RESILIENT LUXURY VINYL TILE FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Resilient Luxury Vinyl Tile/Plank Flooring.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of floor tile. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
 - 1. Show details of special patterns.
- C. Samples for Initial Selection: For each type of floor tile indicated.
- D. Samples for Verification: Full-size units of each color and pattern of floor tile required.
- E. 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 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: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for floor tile installation and seaming method indicated.
- 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 mockups for floor tile including resilient base and accessories.
 - 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 55 deg F or more than 85 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 65 deg F or more than 85 deg F, in spaces to receive floor tile during the following time 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 85 deg F.
- C. Maintain the ambient relative humidity between 40% and 60% during installation.

- D. Close spaces to traffic during floor tile installation.
- E. Close spaces to traffic for 48 hours after floor tile installation.
- F. Install floor tile after other finishing operations, including painting, have been completed.

1.10 WARRANTY

- A. Manufacturer agrees to repair or replace components of tile installation that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For resilient tile flooring, as determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
 - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
- B. Chemical Resistance, ASTM E925.
- C. Static Load Limit, ASTM F 970.
- D. Resistance to Heat, ASTM F 1514.
- E. Resistance to Light, ASTM F1515.
- F. Residual Indentation, ASTM F1914.
- G. Static Coefficient of Friction, ASTM D 2047.
- H. Smoke Density, ASTM E662: ≤ 450 .

2.2 LUXURY VINYL TILE/PLANK

- A. Refer to Finish Schedule on Drawings for manufacturers, products, styles, and colors.
- B. Tile Standard: ASTM F 1700, Class III, Type B.
- C. Wearing Surface: Smooth.

- D. Edge Treatment: Square-Edge.
- E. Thickness: 0.098 inch.
- F. Wear Layer Thickness: 0.020 Inch, 20 mil.
- G. Size: Nominal Dimensions – 7 inches wide x 48 inches long.

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 floor tile manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.
- C. 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 F 710.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.

3. Mechanically remove contamination on the substrate that may cause damage to the resilient flooring material. Permanent and non-permanent markers, pens, crayons, paint, etc., must not be used to write on the back of the flooring material or used to mark the substrate as they could bleed through and stain the flooring material.
 4. 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 7 or more than 9 pH. If the test results are not within the acceptable range of 7 to 9, the installation must not proceed until the problem has been corrected.
 5. Moisture Testing: Proceed with installation only after substrates pass testing according to floor tile manufacturer's written recommendations, but not less stringent than the following:
 - a. Perform anhydrous calcium chloride test according to ASTM F 1869. Proceed with installation only after substrates have maximum Moisture-Vapor-Emission Rate (MVER) of 5 lb of water/1000 sq. ft. in 24 hours.
 - b. Perform relative humidity test using in situ probes according to ASTM F 2170. Proceed with installation only after substrates have a maximum 80 percent relative humidity level.
- C. Wood subfloors must have a minimum 18 inches of cross-ventilated space beneath the bottom of the joist.
1. The floor must be rigid, free of movement.
 2. Single wood and tongue and groove subfloors should be covered with 1/4 inch or 1/2 inch APA approved underlayment plywood.
 - a. Use 1/4 inch thick underlayment panels for boards with a face width of 3 inches or less.
 - b. Use 1/2 inch thick underlayment panels for boards with a face width wider than 3 inches.
 3. Do not install over OSB (Oriented Strand Board), particle board, chipboard, lauan or composite type underlayments.
- D. Fill cracks, holes, depressions, and irregularities in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- E. Floor covering shall not be installed over expansion joints.
- F. Do not install floor tiles until they are the same temperature as the 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.

- G. 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.
- C. Open enough cartons of floor tiles to cover each area, and mix tile to ensure shade variations do not occur within any one area.
- 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. Adhere floor tiles to flooring substrates using manufacturer's adhesive specified for the site conditions, applied to substrate in accordance with adhesive label instructions for proper use.
- G. Roll the flooring in both directions using a 100 pound three-section roller.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting floor tile.
- B. Perform the following operations immediately after completing floor tile installation:
 - 1. Remove adhesive and other blemishes from exposed surfaces.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp-mop surfaces to remove marks and soil.
- C. Protect floor tile from marks, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. No traffic for 24 hours after installation.
- E. No heavy traffic, rolling loads, or furniture placement for 72 hours after installation.
- F. Cover resilient products until Substantial Completion.
- G. Wait 72 hours after installation before performing initial cleaning.

- H. A regular maintenance program must be started after the initial cleaning.

END OF SECTION 096519.53

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SECTION 096723 – RESINOUS FLOORING

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 resinous flooring systems with epoxy body coat(s).
 - 1. Application Method: Self-leveling slurry with broadcast aggregates.

1.3 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include manufacturer's technical data, application instructions, and recommendations for each resinous flooring component required.
- C. Samples for Initial Selection: For each type of exposed finish required.
- D. Samples for Verification: For each resinous flooring system required, 6 inches square, applied to a rigid backing by Installer for this Project.
- E. Material Certificates: For each resinous flooring component, from manufacturer.
- F. Warranty: Sample of special warranty.
- G. Maintenance Data: For resinous flooring to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application.
- B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.
- C. Close spaces to traffic during resinous flooring application and for not less than 24 hours after application, unless manufacturer recommends a longer period.

1.7 WARRANTY

- A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace resinous flooring that fail(s) in materials or workmanship within specified warranty period.

- 1. Warranty Period: 2 years from date of Substantial Completion.

PART 2 – PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. VOC Content of Liquid-Applied Flooring Components: Not more than 100 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Low-Emitting Materials: Flooring system shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emission from Various Sources Using Small-Scale Environment Chambers."
- C. Flammability: Self-extinguishing according to ASTM D 635.

2.2 MANUFACTURERS

- A. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Obtain secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from manufacturer recommended in writing by manufacturer of primary materials.

2.3 MATERIALS

- A. Resinous Flooring: Abrasion-, impact-, and chemical-resistant, decorative flake-broadcast, epoxy-resin-based, monolithic floor surfacing designed to produce a seamless floor and integral cove base.

1. Products: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
 - a. The Sherwin-Williams Company; FasTop Deco Flake SL45; Resuflor Deco Flake BC
 - b. Palma, Inc.; PalFlake
 - c. Stonhard, Inc.; Stonetec

B. EF-1 – CSP 4-6

- FasTop Deco Flake SL45, 3/16" – 1/4" nominal thickness.
 1. Cove Base: FasTop Multi Cove Base, 15-20 linear feet per kit at 6" with 1" radius.
 2. Primer (Optional for outgassing): Resuflor Aqua 3477 at 250 sq. ft. per gallon.
 3. Slurry (1/4"): FasTop Multi SL45 29-32 sq. ft. per kit.
 4. Broadcast: 6750/6755 Decorative Flake at 100 lbs. per 1,000 sq. ft.
 5. Grout Coat: Resuflor 3746 at 100-200 sq. ft. per gallon.
 6. Seal Coat: Elladur 4850 at 250-300 sq. ft. per gallon.
- 7. System Characteristics:
 - A. Color and Pattern: As selected by Architect from manufacturer's full range.
 - B. Wearing Surface: Textured for slip resistance.
 - C. Integral Cove Base: 4 inches high.
 - D. Overall System Thickness: 3/16".
- 8. Primer: Type recommended by resinous flooring manufacturer for substrate and resinous flooring system indicated.
- 9. Urethane Cement Slurry
 - A. Resin: Urethane.
 - B. Formulation Description: 100 percent solids.
 - C. Application Method: Self-leveling urethane cement with broadcast flake.
 - D. Number of Coats: As recommended by manufacturer.
 - E. Aggregates: Colored Flake (1/4" vinyl).
- 10. Topcoat: Chemical-resistant sealing or finish coat(s).
 - A. Resin: Manufacturer Recommended.
 - B. Formulation Description: High solids.
 - C. Type: Clear.

D. Finish: Owner requirements.

11. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:

- A. Compressive Strength: 6,900 psi minimum according to ASTM C 579.
- B. Tensile Strength: 900 psi minimum according to ASTM C 307.
- C. Flexural Strength: 1,900 psi minimum per ASTM C 580.
- D. Water Absorption: 1.0 percent (max.) according to ASTM C 413.
- E. Hardness: 83-90, Shore D according to ASTM D 2240.

C. (EF-2) – CSP 3-5

- Resuflor Deco Flake BC, 20-30 mils nominal thickness.
 - 1. Primer: Resuprime 3579 at 200-300 sq. ft. per gallon.
 - 2. Body Coat: Resuflor 3746 at 200-300 sq. ft. per gallon.
 - 3. Broadcast: Decorative Flakes 6750 or 6755 to excess
 - 4. Grout Coat: Resuflor 3746 at 160-250 sq. ft. per gallon.
 - 5. Seal Coat: Resutile 4686 at 250-400 sq. ft. per gallon.

2.4 ACCESSORY MATERIALS

- A. Patching and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended by manufacturer for application indicated.

PART 3 – EXECUTION

3.1 PREPARATION

- A. Prepare and clean substrates according to resinous flooring manufacturer's written instructions for substrate indicated. Provide clean, dry, substrate for resinous flooring application.
- B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.
 - 1. Roughen concrete substrates as follows:
 - 1) Thin and medium films, 10 to 40 mils CSP-3 to CSP-5
 - 2) Self-leveling mortars, to 3/16" CSP-4 to CSP-6
 - 2. Repair damaged and deteriorated concrete according to resinous flooring

- manufacturers' written instructions.
3. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturers' written instructions.
 - a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with application of resinous flooring only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. of slab area in 24 hours.
 - b. Plastic Sheet Test: ASTM D 4263. Proceed with application only after testing indicates absence of moisture in substrates.
 - c. Perform additional moisture tests recommended by manufacturer. Proceed with application only after substrates pass testing.
 4. Verify that concrete substrates have pH within acceptable range. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.
- C. Patching and Filling: Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.
1. Control Joint Treatment: Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written instructions.
- D. Resinous Materials: Mix components and prepare materials according to resinous flooring manufacturer's written instructions.

3.2 APPLICATION

- A. Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.
1. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
 2. Resinous flooring components shall be cured according to manufacturer's written instructions. Prevent contamination during application and curing processes.
 3. Expansion and Isolation Joints Treatment: At substrate expansion and isolation joints, comply with resinous flooring manufacturer's written instructions.
- B. Primer: Apply primer over prepared substrate at manufacturer's recommended spreading rate.
- C. Integral Cove Base: Apply cove base mix to wall surfaces before applying flooring. Apply according to manufacturer's written instructions and details, including those for taping, mixing, priming, troweling, sanding, and topcoating

of cove base. Round internal and external corners.

- D. Self-Leveling Body Coats: Apply self-leveling slurry body coats in thickness indicated for flooring system.
 - 1. Aggregates: Broadcast aggregates at rate recommended by Manufacturer and, after resin is cured. Remove excess aggregates to provide surface texture indicated.
- E. Grout Coat: Apply grout coat, of type recommended by resinous flooring manufacturer, to fill voids in surface of final body coat.
- F. Topcoats: Apply topcoat(s) in number indicated for flooring system and at spreading rates recommended in writing by manufacturer and to produce wearing surface indicated.

3.3 FIELD QUALITY CONTROL

- A. Material Sampling: Owner may, at any time and any number of times during resinous flooring application, require material samples for testing for compliance with requirements.
 - 1. Owner will engage an independent testing agency to take samples of materials being used. Material samples will be taken, identified, sealed, and certified in presence Contractor.
 - 2. Testing agency will test samples for compliance with requirements, using applicable referenced testing procedures or, if not referenced, using testing procedures listed in manufacturer's product data.
 - 3. If test results show applied materials do not comply with specified requirements, pay for testing, remove noncomplying materials, prepare surfaces coated with unacceptable materials, and reapply flooring materials to comply with requirements.

3.4 PROTECTION

- A. Protect resinous flooring from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.

END OF SECTION 096723

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 modular 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 installation recommendations for each type of substrate.
- B. Shop Drawings: Show the following:
 - 1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
 - 2. Carpet tile type, color, and dye lot.
 - 3. Type of subfloor.
 - 4. Type of installation.
 - 5. Pattern of installation.
 - 6. Pattern type, location, and direction.
 - 7. Pile direction.
 - 8. Type, color, and location of insets and borders.

9. Type, color, and location of edge, transition, and other accessory strips.
10. Transition details to other flooring materials.

C. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.

1. Carpet Tile: Full-size Sample.
2. Exposed Edge, Transition, and Other Accessory Striping: 12-inch-long Samples.

D. Product Schedule: For carpet tile. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.
- C. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:
 1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
 2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.

- B. Fire-Test-Response Ratings: Where indicated, provide carpet tile identical to those of assemblies tested for fire response according to NFPA 253 by a qualified testing agency.
- C. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and 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 CRI 104.

1.10 FIELD CONDITIONS

- A. Comply with 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 occupancy levels 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, more than 10 percent edge raveling, snags, runs, dimensional stability, excess static discharge, loss of tuft bind strength, loss of face fiber, and delamination.
 - 3. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILE

- A. Refer to Finish Schedule on Drawings for manufacturers, products, styles and colors.

2.2 INSTALLATION ACCESSORIES

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

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance. Examine carpet tile for type, color, pattern, and potential defects.
- B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710 and the following:
 - 1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet tile manufacturer.
 - 2. Subfloor finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" for slabs receiving carpet tile.
 - 3. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider and protrusions more than 1/32

inch unless more stringent requirements are required by manufacturer's written instructions.

- C. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet tile manufacturer.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

- A. General: Comply with CRI 104, Section 14, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: Glue down; install every tile with full-spread, releasable, pressure-sensitive adhesive.
- C. Maintain dye lot integrity. Do not mix dye lots in same area.
- D. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
- E. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, non-staining marking device.
- G. Install pattern parallel to walls and borders.

3.4 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet tile:
 - 1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet tile manufacturer.
 - 2. Remove yarns that protrude from carpet tile surface.
 - 3. Vacuum carpet tile using commercial machine with face-beater element.
- B. Protect installed carpet tile to comply with CRI 104, Section 16, and "Protecting Indoor Installations."

- C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 096813

SECTION 098433 - ACOUSTIC ROOM COMPONENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - a. WP-2 - Sound-Diffusers for Drexel Hill MS Auditorium
 - b. Accessories required for proper installation.

1.02 REFERENCE STANDARDS

- A. ASTM International:
 - 1. ASTM C423 Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - 2. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
 - a. Flame Spread; 25 or less.
 - b. Smoke Developed; 450 or less.

1.03 QUALITY ASSURANCE

- A. Single Source Responsibility: Obtain acoustical units from a single manufacturer.
- B. Installer Qualifications: Installer to have a minimum of 5 years documented experience installing the specified product. To provide evidence of appropriate experience in system installation and method proposed and acceptable to panel manufacturer.

1.04 SUBMITTALS

- A. General: Comply with Division 1 Submittal Procedures.
- B. Product Data: Submit product data sheet for specified products.
- C. Samples: Submit selection and verification samples of finishes, colors and textures.
- D. Shop Drawings: Submit drawings showing complete details including all dimensions, materials, finishes, mounting hardware and other pertinent information as may be requested.

1.05 DELIVERY, STORAGE & HANDLING

A. Store Diffusers flat, where protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.

B. Protect Diffusers edges from damage.

1.06 PROJECT CONDITIONS

A. Do not install acoustical units until wet work, such as concrete and plastering, is complete, the building is enclosed, and the temperature and relative humidity are stabilized at 60 - 80 degrees F (16 - 27 degrees C) and 35% MINIMUM RH and 55% MAXIMUM RH, respectively. Maintain temperature and humidity as recommended by panel manufacturer.

1.07 WARRANTY

- A. Comply with requirements of Division 1 – Closeout Submittals
- B. Submit a written warranty, executed by the Contractor, agreeing to repair or replace Diffusers that fail in materials or workmanship within the specified warranty period.
1. Warranty Period: One (1) year after date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. BASIS OF DESIGN: Manufacturer: AVL Systems Inc.
Phone: 800-228-7842
Email: Sales@avlonline.com
Website: www.AVLOnline.com
- B. Acceptable Alternates to meet performance and style of BOD:
- [Kinetics](#) (Hightones)
 - [RPG Acoustical Systems](#)

2.02 MATERIALS

- A. WP-2 - Basis of Design: Prime7FE Diffuser Absorber
- a. Core: Manufactured Hardwood Plank
 - b. Thickness (Nominal): 1" (102 mm)
 - c. Sizes (Nominal): 4" x 96" (custom)

- d. Standard Hardwood Options: Maple
- e. Finish: Per Architects Control Sample
- f. Installation Methods: Nail, Screw, Adhesive, As Required
- g. FSC Certifications: FSC Mix, FSC 100%
- h. Fire Performance: Class A

6. Mounting: Nail, Screw, Adhesive, As Required

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine substrates, with installer present, for compliance with requirements of conditions affecting performance of product. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PROTECTION

- A. Protect Diffusers during remainder of construction period to ensure they are without damage at time of Substantial Completion.

3.3 INSTALLATION

- A. Comply with panel manufacturer's printed instructions for installation of acoustical units using the type of mounting accessories indicated or, if none indicated, as recommended by manufacturer.

END OF SECTION

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SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes surface preparation and the application of paint systems on interior substrates.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Samples for Initial Selection: For each type of topcoat product.
- C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.
 - 1. Submit Samples on rigid backing, 8 inches square.
 - 2. Step coats on Samples to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Show gray, "P" shade primer when color selection requires gray primer.
 - 5. Label each Sample for location and application area.
- D. Product List: For each product indicated, include the following:
 - 1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
 - 2. VOC content.

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. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

2. Coating Maintenance Manual: Upon conclusion of the project, the Contractor or paint manufacturer/supplier shall furnish a coating maintenance manual, such as Sherwin-Williams "Custodian Project Color and Product Information" report. Manual shall include an Area Summary with finish schedule, Area Detail designating where each product/color/finish was used, product data pages, Material Safety Data Sheets, care and cleaning instructions, touch-up procedures, and color samples of each color and finish used.

1.5 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft.
 - b. Other Items: Architect will designate items or areas required.
 2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 1. Maintain containers in clean condition, free of foreign materials and residue.
 2. Remove rags and waste from storage areas daily.

1.7 FIELD CONDITIONS

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, products by Sherwin Williams are the basis of design and set the standard of quality required.
 - 1. Sherwin-Williams Company (The) Basis of Design.
 - 2. PPG Paints
 - a. Jeff Skuba CSI, CDT, ACT p: 215.527.6790 e: jskuba@ppg.com

2.2 PAINT, GENERAL

- A. Material Compatibility:
 - 1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- B. Colors: As selected by Architect from manufacturer's full range.
- C. Total VOC content will not be increased by tints and colorants required.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Concrete: 12 percent.
 - 2. Masonry (Clay and CMU): 12 percent.
 - 3. Wood: 15 percent.
 - 4. Gypsum Board: 12 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Spray-Textured Ceiling Substrates: Verify that surfaces are dry.

- E. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- F. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceed that permitted in manufacturer's written instructions.
- F. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer.
- G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- I. Aluminum Substrates: Remove loose surface oxidation.
- J. Wood Substrates:

1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
2. Sand surfaces that will be exposed to view, and dust off.
3. Prime edges, ends, faces, undersides, and backsides of wood.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions.
 1. Use applicators and techniques suited for paint and substrate indicated.
 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
 1. Paint the following work where exposed in equipment rooms:
 - a. Equipment, including panelboards.
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Tanks that do not have factory-applied final finishes.
 - h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 2. Paint the following work where exposed in occupied spaces:

- a. Equipment, including panelboards.
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 - h. Other items as directed by Architect.
3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
1. Contractor shall touch up and restore painted surfaces damaged by testing.
 2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 SCHEDULE - INTERIOR SURFACES - LATEX

- A. Total VOC content will not be increased by tints and colorants required.
- B. Shop Primed Ferrous Metal: Semi-Gloss Finish:
1. Sherwin-Williams:

- a. Primer: Pro Industrial Pro-Cryl Universal primer.
 - b. Finish: Two coats Pro Industrial High Performance Acrylic, semi-gloss.
 - 2. PPG PAINTS:
 - a. Primer: Pitt Tech Plus Waterborne Acrylic Primer/Finish 4020 PF
 - b. Finish: Two Coats Pitt Tech Plus Waterborne Acrylic Semi-Gloss 4216HP
- C. Ferrous Metal and Galvanized Metals: Semi-Gloss Finish:
- 1. Sherwin-Williams:
 - a. Primer: Pro Industrial Pro-Cryl Universal primer.
 - b. Finish: Two coats Pro Industrial High Performance Acrylic, semi-gloss.
 - 2. PPG PAINTS:
 - a. Primer: Pitt Tech Plus Waterborne Acrylic Primer/Finish 4020 PF
 - b. Finish: Two Coats Pitt Tech Plus Waterborne Acrylic Semi-Gloss 4216HP
- D. Concrete Masonry Units (CMU): Semi-Gloss Finish:
- 1. Sherwin-Williams:
 - a. Filler: One coat PrepRite Interior/Exterior Block Filler B25W25.
 - b. Finish: Two coats ProMar 200 Zero VOC, semi-gloss.
 - 2. PPG PAINTS
 - a. Primer: One Coat SPEEDHIDE® Int/Ext Masonry Hi Fill Latex Block Filler 6-15XI
 - b. Finish: Two Coats SPEEDHIDE® zero Int Zero-VOC Latex Semi-Gloss 6-4510XI
 - 3. Acoustical CMU Blocking is to be Rolled only. Spraying is not allowed.
- E. Exposed Metal Deck & Joists: Flat Acrylic:
- 1. Sherwin-Williams:
 - a. Primer: (Ferrous and Non-Ferrous Metal): ProIndustrial Pro-Cryl Primer.
 - b. Finish: ProIndustrial Waterborne Acrylic Dryfall, Flat.
 - 2. PPG PAINTS
 - a. Primer: spot prime with Pitt-Tech® Plus Int/Ext DTM Industrial Primer 4020 PF

- b. Finish: SPEEDHIDE® SUPER TECH® WB Interior Dry-Fog Flat Latex, 6-725XI.
- 3. Spot Priming required at all exposed metal substrates, the edges, welds & nuts/bolts.

F. Gypsum Board: Flat Finish:

- 1. Sherwin-Williams:
 - a. Primer: One coat. ProMar 200 Zero VOC Primer.
 - b. Finish: Two coats. ProMar 200 Zero VOC, Flat.
- 2. PPG PAINTS
 - a. Primer: One Coat SPEEDHIDE® Zero Int Latex Sealer 6-4900XI
 - b. Finish: Two Coats SPEEDHIDE® Zero Int Zero-VOC Latex Flat 6-4110XI

G. Gypsum Board: Eggshell Finish:

- 1. Sherwin-Williams:
 - a. Primer: One coat ProMar 200 Zero VOC Primer.
 - b. Finish: Two coats ProIndustrial Pre-Catalyzed WaterBased Epoxy, eg-shell
- 2. PPG PAINTS
 - a. Primer: One Coat SPEEDHIDE® Zero Int Latex Sealer 6-4900XI
 - Finish: Two Coats SPEEDHIDE® Zero Int Latex Eggshell 6-4310XI

H. Impact / moisture resistant Gypsum board - Eggshell Finish:

- 1. Sherwin-Williams:
 - a. Primer: One coat PrepRite ProBlock Latex Primer Sealer, B51-600, no substitutions
 - b. Finish: Two coats ProIndustrial Pre-Catalyzed WaterBased Epoxy, eg-shell
- 2. PPG PAINTS
 - a. Primer: SEAL GRIP Int/Ext Acrylic Universal Primer/Sealer 17-921XI series
 - b. Finish: Two Coats Pitt-Glaze WB 1 Epoxy 16-300 series (< 100 g/L VOC)

I. Gypsum Board: Semi-Gloss Finish:

1. Sherwin-Williams:
 - a. Primer: One coat ProMar 200 Zero VOC Primer.
 - b. Finish: Two coats ProMar 200 Zero VOC, semi-gloss.
 2. PPG PAINTS
 - a. Primer: One Coat SPEEDHIDE® Zero Int Latex Sealer 6-4900XI
Finish: Two Coats SPEEDHIDE® Zero Int Latex Semi-Gloss 6-4510XI
- J. Gypsum Board Under Vinyl Wall Covering: Latex Primer:
1. Sherwin-Williams:
 - a. One coat: Multi-Purpose Latex Primer.
 2. PPG PAINTS
 - a. One Coat: SEAL GRIP® Int/Ext Acrylic Universal Primer/Sealer 17-921XI series
- K. Wood: Semi-Gloss Finish – 100% acrylic:
1. Sherwin-Williams:
 - a. Primer: Not required.
 - b. Finish: Two coats Solo 100% Acrylic, semi-gloss.
 2. PPG PAINTS
 - a. Primer: not required
 - b. Finish: Two Coats, Speedhide Zero Interior Semi-Gloss, 6-4510XI
- L. Concrete: clear penetrating sealer
1. Sherwin-Williams:
 - a. Primer: Not required.
 - b. Finish: GP 3477 Epoxy Sealer
 2. PPG PAINTS
 - a. Primer: not required
 - b. Finish: single flood coat PERMA-CRETE® Aqua-Pel™ Clear Water Repellent 4-6100 series

END OF SECTION 099123

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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. Markerboards (Whiteboards).
 - 2. Tackboards.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For visual display surfaces. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Show locations of panel joints.
 - 2. Include sections of typical trim members.
- C. Samples: For each exposed product and for each color and texture specified.

1.4 INFORMATIONAL SUBMITTALS

- A. Product test reports.
- B. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.6 WARRANTY

- A. Special Warranty for Porcelain-Enamel Face Sheets: Manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 50 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.

2.2 MARKERBOARD (WHITEBOARD) ASSEMBLIES

- A. Porcelain-Enamel MAGNETIC 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 High-gloss finish. Laminate panels under heat and pressure with manufacturer's standard, flexible waterproof adhesive. Provide Narrow Profile Board.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Claridge Products and Equipment, Inc.(Series 8 with 5/16" perimeter trim)
- b. Marsh Industries, Inc.; Visual Products Group.
- c. Platinum Visual Systems; a division of ABC School Equipment, Inc.
- d. Nelson Adams NACO.

2. Manufacturer's Standard Core: Minimum 1/2 inch thick, with manufacturer's standard moisture-barrier backing.
3. Laminating Adhesive: Manufacturer's standard, moisture-resistant thermoplastic type.

- B. Aluminum Frames and Trim: Fabricated from not less than 0.062-inch thick, extruded aluminum; of size and shape indicated on Drawings.

1. Aluminum Finish: Clear anodic finish.

- a. Color: As selected by Architect from full range of industry colors and color densities.

- C. Chalktray: Manufacturer's standard; continuous.

1. Solid Type: Extruded aluminum with ribbed section and smoothly curved exposed ends.

- D. Display Rail: Manufacturer's standard, extruded-aluminum display rail with plastic-impregnated-cork insert, end stops, designed to hold accessories.

1. Size: Length indicated on Drawings.
2. Map Hooks: Two map hooks for every 48 inches of display rail or fraction thereof.
3. Map Hooks and Clips: Two map hooks with flexible metal clips for every 48 inches of display rail or fraction thereof.
4. Flag Holder: One for each Classroom.
5. Tackboard Insert Color: As selected by Architect from full range of industry colors.
(NOT INSTALLED OVER CENTER BOARD ARRANGEMENTS AT TEACHING WALL
TO ALLOW FOR SHORT THROW PROJECTOR INSTALLATION)
6. Aluminum Color: Match finish of visual display assembly trim.

E. Paper Holder Display Rail: Extruded aluminum; designed to hold paper by clamping action.

2.3 TACKBOARD ASSEMBLIES

- A. Basis of Design: Forbo, Bulletin Board pin board linoleum. Substitutions by approval of the Architect.
- B. Tackboard Panels:
1. Facing: 1/4-inch thick, plastic-impregnated cork.
 2. Core: Manufacturer's standard.
- C. Aluminum Frames and Trim: Fabricated from not less than 0.062-inch thick, extruded aluminum; of size and shape indicated on Drawings.
1. Aluminum Finish: Clear anodic finish.
 - a. Color: As selected by Architect from full range of industry colors and color densities.

2.4 MATERIALS

- A. Porcelain-Enamel Face Sheet: PEI-1002, with face sheet manufacturer's standard two- or three-coat process.
- B. Tackboard Panels: Seamless, homogeneous, self-healing sheet consisting of natural materials (cork, linseed oil, jute).
- C. Extruded Aluminum: ASTM B 221, Alloy 6063.
- D. Clear Tempered Glass: ASTM C 1048, Kind FT, Condition A, Type I, Class 1, Quality Q3, with exposed edges seamed before tempering.
- E. High-Pressure Plastic Laminate: NEMA LD 3.
- F. Fasteners: Provide screws, bolts, and other fastening devices made from same material as items being fastened, except provide hot-dip galvanized, stainless-steel, or

aluminum fasteners for exterior applications. Provide types, sizes, and lengths to suit installation conditions. Use security fasteners where exposed to view.

- G. 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 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.1 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. FULLY ADHERE AT TEACHING WALL WITH ADHESIVE to PREVENT BOWING OF WHITEBOARDS.
- 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, as indicated on approved Shop Drawings.
 - 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: 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.

END OF SECTION 101100

SECTION 101400 – INTERIOR SIGNAGE

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Room Identification signage.
 - 2. Restrooms.
 - 3. Informational Signage.
 - 4. Directory Signs.
 - 5. Signage for ADA and Life Safety Code Compliance.

1.2 REFERENCES

- A. ANSI 117.1 – For Buildings and Facilities
- B. ASTM International (ASTM) D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
- C. ASTM International (ASTM) E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- D. ASTM International (ASTM) D1929 - Standard Test Method for Determining Ignition Temperature of Plastics.
- E. Underwriters Laboratories (UL) 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
- F. Underwriters Laboratories (UL) 723 - Standard for Test for Surface Burning Characteristics of Building Materials.
- G. ASTM E2072-04 - (American Society for Testing and Material) and DIN 67510.
- H. ASTM E2073-02 - (Standard Test Method for Photopic Luminance of Photo luminescent (Phosphorescent) Markings).
- I. ADAAG – Americans with Disabilities Act Accessibility Guidelines; US Architectural and Transportation Barriers Compliance Board.
- J. National Fire Protection Association - 101 Life Safety Code

1.3 PERFORMANCE REQUIREMENTS

- A. Provide photopolymer signage that conforms to the requirements of all regulatory agencies holding jurisdiction and the quality control of selected signage manufacturer.
- B. Requirements:
 - 1. Comply with all applicable provisions of the ADA and ANSI A117.1-1998.
 - 2. Character Proportion: Letters and numbers on signs must have a width-to-height ratio between 3:5 and 1:1 and a stroke width-to-height ratio between 1:5 and 1:10.
 - 3. Color Contrast: Characters and symbols must contrast with their background - either light characters on a dark background or dark characters on a light background.
 - 4. Raised Characters or Symbols: Letters and numbers on signs must be raised 1/32 in (0.8 mm) minimum and be sans serif characters. Raised characters or symbols must be at least 5/8 in (16 mm) high, but no higher than 2 in (50 mm). Symbols or pictograms on signs must be raised 1/32 in (0.8 mm) minimum.
 - 5. Symbols of Accessibility: Accessible facilities required to be identified must use the international symbol of accessibility.
 - 6. Braille: Grade II with accompanying text.
- C. Fire Performance Characteristics:
 - 1. Provide photopolymer signage with surface burning characteristics that consist of a flame spread of 75 and a smoke development of 120 when tested in accordance to UL 723 (ASTM E 84).
 - 2. Self Extinguishing: Provide photopolymer signage with a CC1 classification for .060-inch thick material when tested in accordance with the procedures in ASTM D 635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning Plastics in a Horizontal Position.
 - 3. Vertical Burn: Provide photopolymer material that is classified as 94V-2 for material .118 inches thick or greater and 94HB for material .118 inches thick or less when tested in accordance with UL 94, Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
 - 4. Self-Ignition Temperature: Provide photopolymer material that has a self-ignition temperature of 800 F (427C) when tested in accordance with ASTM D 1929.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
 2. Storage and handling requirements and recommendations.
 3. Installation methods.
- C. Shop Drawings: Detail drawings showing materials, lay-out, sizes, lettering and graphics, construction details of each type of sign and mounting details with appropriate fasteners for specific project substrates.
- D. Selection Samples: For each finish product specified, two sets of color sheets representing manufacturer's full range of available colors and patterns.
- E. Verification Samples: For each sign type and color specified, two samples, minimum size 6 inches (150 mm) square, representing actual product, color, patterns, overall quality, and adherence to drawings and references indicated.
- F. Manufacturer's Installation Instructions: Printed installation instructions for each signage system.
- G. Message List: Signage report indicating signage location, text and sign type.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in unopened factory packaging.
- B. Inspect materials at delivery to verify there are no defects or damage.
- C. Store products in manufacturer's original packaging until ready for installation, in climate-controlled location away from direct sunlight.
- D. Store and dispose of solvent-based materials, and materials used with solvent-based materials in accordance with requirements of local authorities having jurisdiction.

1.6 PROJECT CONDITIONS

- A. Install products in an interior climate-controlled environment.
- B. Maintain environmental conditions (temperature, humidity and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.7 WARRANTY

- A. At project closeout, provide to the Owner or Owner's representative a copy of the manufacturer's standard limited warranty against manufacturing defect outlining

the terms, conditions and exclusions from coverage.

1. Duration: One (1) year.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Signage shall be as manufactured by FastSigns of Lancaster or Architect approved equal. Other acceptable manufacturers include Berry and Homer, Inc. (Chester, PA), Takeform and ASI.
- B. Provide all signage from one manufacturer.
- C. Substitutions: Bidder must obtain prior written approval from the Architect and/or Owner to bid alternates or substitutions to the specification.

2.2 SIGNAGE – GENERAL

- A. It is the intent of these specifications to establish a sign standard for the Owner including but not limited to primary and secondary directories, wall mounted and overhead directional signs, primary room identification, restrooms, conference rooms, work station ID's and all code compliant signage. The signage contractor shall design and submit approval drawings for all sign types relevant to the project.
- B. Comply with all applicable provisions of the ADAAG and ANSI A117.1 codes that apply to the State and Local jurisdiction of the project.
- C. Typography: See Drawings. Copy shall be a true, clean and accurate reproduction of typeface(s) specified. Upper and lower case and all caps as indicated in Sign Type drawings and Signage Schedule. Letter spacing to be normal and interline spacing set by manufacturer.
- D. Arrows, symbols and pictograms will be provided in style, sizes, colors and spacing as indicated in drawings for each sign system.
- E. Braille
 1. Grade 2 Braille utilizing perfectly round, clear insertion beads.
- F. Design
 1. Text/Graphics Placement: As indicated on contract drawings.
 2. Colors, patterns, and artwork: As indicated on contract drawings.
 3. Message Background: As indicated on contract drawings.

4. Finishes are to meet current federal ADA and all state and local requirements.

2.3 IDENTIFICATION SIGNAGE

A. Signage System:

1. The signage shall incorporate a decorative laminate face with applied graphics including all tactile requirements in adherence to ADA specifications.
2. All signs, including workstation and room ID's, overheads and flag mounts, directional and directories, shall have a matching appearance and constructed utilizing the same manufacturing process to assure a consistent look throughout.

B. Materials:

1. Sign face shall be 0.035" (nominal) standard grade, high pressure surface laminate. A painted sign face shall not be acceptable.
2. The sign shall incorporate balanced construction with the core sandwiched between laminates to prevent warping. Laminate on the sign face only shall not be acceptable.
3. Tactile lettering shall be precision machined, raised 1/32", matte PETG and subsurface colored for scratch resistance.
4. Signs shall incorporate a metal accent bar. Bars shall be anodized with a brushed satin finish. Painted bars shall not be acceptable. Refer to drawings.

C. Standard Colors:

1. Face/background color shall be standard grade, high pressure laminate, all colors and finishes as selected by architect from a full range of manufacturer standard colors.
2. Standard tactile colors shall match manufacturer's ADA standard color selection. Refer to drawings.

D. Construction:

1. The signage shall, with the exception of directories and directional, be a uniform 8 1/2" width to facilitate inserts printed on standard width paper.
2. Insert components shall have a .080 thickness non-glare acrylic window and shall be inlaid flush to sign face for a smooth, seamless appearance.
3. The signage shall include modules allowing for inserts, notice holders, occupancy sliders, marker, magnetic, and cork boards. All modules shall be flush to sign face for a smooth, seamless appearance.
4. The laminates (front and back) shall be pressure laminated and precision

machined together to a 90-degree angle. Edges shall be smooth, void of chips, burrs, sharp edges and marks.

5. The signage shall utilize an acrylic sphere for Grade II Braille inserted directly into a scratch resistant, high pressure laminate sign face. Braille dots are to be pressure fit in high tolerance drilled holes.
6. Braille dots shall be half hemispherical domed and protruding a minimum 0.025".
7. The signage shall utilize a pressure activated adhesive. The adhesive shall be nonhazardous and shall allow for flexing and deflection of the adhered components due to changes in temperature and moisture without bond failure.
8. All signs shall be provided with appropriate mounting hardware. Hardware shall be finished and architectural in appearance and suitable for the mounting surface.
9. Some signs may be installed on glass. A blank backer is required to be placed on the opposite side of the glass to cover tape and adhesive. The backer shall match the sign in size and shape and color.

E. Printed Inserts:

1. The signage shall be capable of accepting paper or acetate inserts to allow changing and updating as required. Insert components shall have a 0.080" thickness non-glare acrylic window and shall be inlayed flush to sign face for a smooth, seamless appearance.
2. The signage contractor shall provide and install all signage inserts.
3. Manufacturer shall provide a template containing layout, font, color, artwork, and trim lines to allow Owner to produce inserts on laser or ink jet printer. The template shall be in an Acrobat or Word format (.pdf).

PART 3 – EXECUTION

3.1 SITE VISITS

A. Site Visits – 3 site visits shall be required by the sign contractor:

1. Prior to submission of bid for site assessment and evaluation.
2. Post award for the purposes of meeting with Owners and project manager.
3. Final walk-through and punchlist.

B. Programming. Sign contractor shall perform all wayfinding & programming. Programming shall include location plan, message schedule, and/or plots, fire/evacuation maps and insert graphics. All programming materials shall be submitted for approval.

3.2 EXAMINATION

- A. Verify that wall surface is dry and free from dirt, grease and loose paint.
- B. Complete all finishing operations, including painting, before beginning installation of signage systems.
- C. Do not begin installation until substrates have been properly prepared.
- D. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- E. Examine signage for defects, damage and compliance with specifications prior to installation. Do not install damaged signage.

3.3 CODE COMPLIANCE

- A. It shall be the responsibility of the successful bidder to meet any and all local, state, and federal code requirements in fabricating and installing signs.

3.4 PREPARATION

- A. Verify mounting heights and locations comply with referenced standards.
- B. Clean surfaces thoroughly prior to installation to remove dust, debris and loose particles.
- C. Prepare surfaces using the methods recommended by the manufacturer for achieving the best results for the substrate under the project conditions.

3.5 INSTALLATION

- A. General: Installation locations shall be in accordance with ADA specifications. Locate signs where indicated using mounting methods in compliance with manufacturer's written instructions:
 - 1. The signage contractor shall coordinate installation schedules with the Owner and/or Construction Manager.
 - 2. Installation shall be performed by manufacturer's personnel trained and certified in manufacturer's methods and procedures.
 - 3. The signage contractor shall submit a CAD generated location plan noting the location of all signage and cross referenced to message schedule or plots for architect's approval.
 - 4. Installer to conduct a pre-installation survey prior to manufacturing to verify copy and sign location. Each location shall be noted using a low tack vinyl

reproduction of actual sign. Full scale renderings of directories and directional shall also be provided. Any location discrepancy or message issues shall be submitted to architect for review.

5. Signs shall be plumb, level, and at heights indicated with sign surfaces free from defects.
6. Upon completion of the work, signage contractor shall remove unused or discarded materials, containers and debris from site.

3.6 CLEANING

- A. At completion of installation, clean surfaces in accordance with manufacturer's instructions.

3.7 DELIVERY, STORAGE, PROTECTION

- A. Protect installed products until completion of project.
- B. Package to prevent damage or deterioration during shipment, handling, storage and installation. Products should remain in original packaging until removal is necessary. Store products in a dry, indoor location.
- C. Touch-up, repair or replace damaged products before substantial completion.

3.8 SIGNAGE SCHEDULE

- A. Room signs: Furnish one sign for each interior door listed on the door schedule and at all cased openings into spaces. Provide additional blank sign for any room signs mounted on glass. Room numbering schedule to be provided by Owner.
- B. ADA Restroom Signs: Furnish one pictogram sign for each restroom.
- C. Provide minimum (4) four directory/way finding signs sized 24"H x 36"W, locations to be determined by Owner.
- D. Provide additional EXIT signage at any Vestibule locations identified by the Authority Having Jurisdiction.

3.9 STANDARDS MANUAL

- A. Manufacturer shall provide a comprehensive Standards Manual in both a paper and PDF format. The manual shall include all graphic standards, sign type descriptions, renderings showing color, pattern and finish, engineering drawings, location plans, plots, artwork, insert templates, mounting detail, and reorder information.

END OF SECTION 101400

SECTION 102113 - TOILET COMPARTMENTS

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-plastic toilet compartments configured as toilet enclosures and urinal screens.

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 toilet compartments.
- B. Shop Drawings: For toilet compartments.
 - 1. Include plans, elevations, sections, details, and attachment details.
 - 2. Show locations of cutouts for compartment-mounted toilet accessories.
 - 3. Show locations of centerlines of toilet fixtures.
 - 4. Show locations of floor drains.
 - 5. Show overhead support or bracing locations.
- C. Samples for Initial Selection: For each type of toilet compartment material indicated.
 - 1. Include Samples of hardware and accessories involving material and color selection.
- D. Samples for Verification: For the following products, in manufacturer's standard sizes unless otherwise indicated:
 - 1. Each type of material, color, and finish required for units, prepared on 6-inch-square Samples of same thickness and material indicated for Work.
 - 2. Each type of hardware and accessory.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of toilet compartment, from manufacturer.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For toilet compartments to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents and source.
 - 1. Door Hinges: One hinge(s) with associated fasteners.
 - 2. Latch and Keeper: One latch(es) and keeper(s) with associated fasteners.
 - 3. Door Bumper: One bumper(s) with associated fasteners.
 - 4. Door Pull: One door pull(s) with associated fasteners.
 - 5. Fasteners: Ten fasteners of each size and type.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for toilet compartments designated as accessible.

2.2 SOLID-PLASTIC TOILET COMPARTMENTS

- 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. Scranton Products (Santana/Comtec/Capitol)
 - 2. Bradley Corporation; Mills Partitions.
 - 3. General Partitions Mfg. Corp.

4. Global Partitions.

- B. Toilet-Enclosure Style: Overhead braced floor anchored.
- C. Urinal-Screen Style: Floor supported.
- D. Door, Panel, and Pilaster Construction: Solid, high-density polyethylene (HDPE) or polypropylene (PP) panel material, not less than 1 inch thick, seamless, with eased edges, and with homogenous color and pattern throughout thickness of material.
 - 1. Heat-Sink Strip: Manufacturer's standard continuous, extruded-aluminum strip fastened to exposed bottom edges of solid-polymer components to prevent burning.
 - 2. Color and Pattern: As selected by Architect from manufacturer's full range.
- E. Pilaster Shoes: Manufacturer's standard design; stainless steel.
- F. Brackets (Fittings):
 - 1. Stirrup Type: Ear or U-brackets, clear-anodized aluminum.
 - 2. Full-Height (Continuous) Type: Manufacturer's standard design; extruded aluminum.

2.3 HARDWARE AND ACCESSORIES

- A. Hardware and Accessories: Manufacturer's standard operating hardware and accessories.
 - 1. Material: Stainless steel.
 - 2. Hinges: Manufacturer's standard continuous, cam type that swings to a closed or partially open position.
 - 3. Latch and Keeper: Manufacturer's standard surface-mounted latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible.
 - 4. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories.
 - 5. Door Bumper: Manufacturer's standard rubber-tipped bumper at out-swinging doors.
 - 6. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible.
- B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.
- C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel or chrome-plated steel or brass, finished to match the items they are securing,

with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized steel, or other rust-resistant, protective-coated steel.

2.4 MATERIALS

- A. Aluminum Castings: ASTM B 26/B 26M.
- B. Aluminum Extrusions: ASTM B 221.
- C. Stainless-Steel Sheet: ASTM A 666, Type 304, stretcher-leveled standard of flatness.
- D. Stainless-Steel Castings: ASTM A 743/A 743M.

2.5 FABRICATION

- A. Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.
- B. Door Size and Swings: Unless otherwise indicated, provide 24-inch- wide, in-swinging doors for standard toilet compartments and 36-inch- wide, out-swinging doors with a minimum 32-inch- wide, clear opening for compartments designated as accessible.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for fastening, support, alignment, operating clearances, and other conditions affecting performance of the Work.
 - 1. Confirm location and adequacy of blocking and supports required for installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.
 - 1. Maximum Clearances:

- a. Pilasters and Panels: 1/2 inch.
 - b. Panels and Walls: 1 inch.
2. Stirrup Brackets: Secure panels to walls and to pilasters with no fewer than two brackets attached near top and bottom of panel.
- a. Locate wall brackets so holes for wall anchors occur in masonry or tile joints.
 - b. Align brackets at pilasters with brackets at walls.
- B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than 1-3/4 inches into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels, and adjust so tops of doors are parallel with overhead brace when doors are in closed position.
- C. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

3.3 ADJUSTING

- A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION 102113

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SECTION 102600 - WALL AND DOOR PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Corner guards.

1.3 ACTION SUBMITTALS

- A. Product Data: Include construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes for each wall and door protection unit.
- B. Shop Drawings: For each impact-resistant wall protection unit showing locations and extent. Include sections, details, and attachments to other work.
- C. Samples for Initial Selection: For each type of corner guard indicated.
- D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
 - 1. Corner Guards: 12 inches long.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Certificates: For each impact-resistant plastic material, from manufacturer.
- C. Material Test Reports: For each impact-resistant plastic material.
- D. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each impact-resistant wall protection unit to include in maintenance manuals.
 - 1. Include recommended methods and frequency of maintenance for maintaining optimum condition of plastic covers under anticipated traffic and use conditions. Include precautions against using cleaning materials and methods that may be detrimental to plastic finishes and performance.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Corner-Guard Covers: Full-size plastic covers of maximum length equal to 2 percent of each type, color, and texture of units installed, but no fewer than two, 4-foot-long units.
- B. Include mounting and accessory components. Replacement materials shall be from same production run as installed units.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
- B. Source Limitations: Obtain impact-resistant wall protection units from single source from single manufacturer.
- C. Product Options: Drawings indicate size, profiles, and dimensional requirements of impact-resistant wall protection units and are based on the specific system indicated. Refer to Section 014000 "Quality Requirements."
- D. Revise subparagraph below to suit Project.
 - 1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
- E. Surface-Burning Characteristics: Provide impact-resistant, plastic wall protection units with surface-burning characteristics as determined by testing identical products per ASTM E 84, NFPA 255, or UL 723 by UL or another qualified testing agency.
- F. Preinstallation Conference: Conduct conference at Project site.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store impact-resistant wall protection units in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
 - 1. Maintain room temperature within storage area at not less than 70 deg F during the period plastic materials are stored.
 - 2. Store plastic wall protection components for a minimum of 72 hours, or until plastic material attains a minimum room temperature of 70 deg F.
 - a. Store corner-guard covers in a vertical position.

1.9 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install wall and door protection units until building is enclosed and weatherproof, wet work is complete and dry, and HVAC system is operating and maintaining temperature at 70 deg F for not less than 72 hours before beginning installation and for the remainder of the construction period.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of wall and door protection units that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. PVC Plastic: ASTM D 1784, Class 1, textured, chemical- and stain-resistant, high-impact-resistant PVC or acrylic-modified vinyl plastic with integral color throughout; thickness as indicated.
 - 1. Impact Resistance: Minimum 25.4 ft-lbf/in. of notch when tested according to ASTM D 256, Test Method A.
 - 2. Chemical and Stain Resistance: Tested according to ASTM D 543.
 - 3. Self-extinguishing when tested according to ASTM D 635.
 - 4. Flame-Spread Index: 25 or less.
 - 5. Smoke-Developed Index: 450 or less.

- B. Aluminum Extrusions: Alloy and temper recommended by manufacturer for type of use and finish indicated, but with not less than strength and durability properties specified in ASTM B 221 for Alloy 6063-T5.
- C. Fasteners: Aluminum, nonmagnetic stainless-steel, or other noncorrosive metal screws, bolts, and other fasteners compatible with items being fastened.

2.2 CORNER GUARDS

- A. Surface-Mounted, Resilient, Plastic Corner Guards: Assembly consisting of snap-on plastic cover installed over continuous retainer; including mounting hardware; fabricated with 90-degree turn to match wall condition.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Construction Specialties, Inc.; SSM-20, or comparable product by one of the following:
 - a. Balco, Inc.
 - b. IPC Door and Wall Protection Systems; Division of InPro Corporation.
 - c. Korogard Wall Protection Systems; a division of RJF International Corporation.
 - d. Pawling Corporation.
 - 2. Cover: Extruded rigid plastic, minimum 0.078-inch wall thickness; in dimensions and profiles as follows.
 - a. Profile: Nominal 2-inch-long leg and 1/4-inch corner radius.
 - b. Height: 4 feet.
 - c. Color and Texture: As selected by Architect from manufacturer's full range.
 - 3. Retainer: Minimum 0.060-inch-thick, one-piece, extruded aluminum.
 - 4. Top and Bottom Caps: Prefabricated, injection-molded plastic; color matching cover; field adjustable for close alignment with snap-on cover.

2.3 MANUFACTURED UNITS

- A. Rigid Vinyl Sheet – wall protection for corridors
 - 1. Rigid Vinyl Sheet Options
 - Item # Dimensions Thickness
 - 405 4'x8' (1.22m x 2.44m) .040" = 3/64" (1mm), standard
 - 406 4'x8' (1.22m x 2.44m) .060" = 1/16" (1.5mm), standard
 - Colors: to be selected from manufacturer's standard line of wood look finishes.
 - Backing – unbacked.

2.4 FABRICATION

- A. Fabricate wall protection units to comply with requirements indicated for design, dimensions, and member sizes, including thicknesses of components.
- B. Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.
- C. Fabricate components with tight seams and joints with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Examine walls to which wall protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Complete finishing operations, including painting, before installing impact-resistant wall protection system components.
- B. Before installation, clean substrate to remove dust, debris, and loose particles.

3.3 INSTALLATION

- A. Install wall protection units level, plumb, and true to line without distortions, in accordance with manufacturer's installation instructions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.
 - 1. Install wall protection units in all outside gypsum board wall corners in corridors.

3.4 CLEANING

- A. Immediately after completion of installation, clean plastic covers and accessories using a standard, ammonia-based, household cleaning agent.

END OF SECTION 102600

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SECTION 102800 - TOILET AND BATH ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Public-use washroom accessories.
 - 2. Under lavatory guards.
 - 3. Electric hand dryers.
 - 4. ADA Locker Room Benches
 - 5. Changing Tables

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include the following:
 - 1. Construction details and dimensions.
 - 2. Anchoring and mounting requirements.
 - 3. Material and finish descriptions.
 - 4. Manufacturer's warranty.
- B. Samples: Full size, for each accessory item to verify design, operation, and finish requirements.
 - 1. Approved full-size Samples will be returned and may be used in the Work.
- C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
 - 1. Identify locations using room designations indicated.
 - 2. Identify products using designations indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For toilet and bath accessories to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Source Limitations: For products listed together in the same Part 2 articles, obtain products from single source from single manufacturer.

1.7 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.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, 0.031-inch minimum nominal thickness unless otherwise indicated.
- B. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.
- C. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.2 TOILET AND BATH ACCESSORIES

- A. Refer to Toilet Accessories Schedule on Drawings for manufacturers, products, and finishes.

2.3 UNDERLAVATORY GUARDS

- 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. IPS Corporation; Truebro® Lav Guard 2 Series.

2. Plumberex Specialty Products, Inc.; Pro-Extreme.

B. Underlavatory Guard:

1. Description: Insulating pipe covering for supply and drain piping assemblies that prevent direct contact with and burns from piping; allow service access without removing coverings.
2. Material and Finish: Antimicrobial, molded plastic, white.

2.4 HIGH-SPEED HAND DRYERS

- A. Subject to compliance with requirements, provide hand dryers by Excel or approved equal.

B. "11a" Automatic Hand Dryer – Surface Mounted

1. Basis of Design Product: Excel Dryer, Inc Thin Air Hand Dryer
2. Mounting: Surface Mounted
3. Operation: Automatic
4. Electrical Requirements: Universal Voltage automatically configures the dryer to operate on 110-120V
5. Finish: Brushed Stainless Steel

2.5 Toilet Room Accessories

- A. "1 and 1b" – Toilet Grab Bars – (ADA toilet stall) Basis of Design: Bradley Accessories; Model Numbers: Heavy Duty 812 / Finish 2 Reference Drawings for length of grab bars: (36,48,12 inch lengths)
- B. "3" – Mirror – Reference Drawings for Location Basis of Design: Frameless, SS 18x30 inch (accessible Mirror, ADA regulations)
- C. "4" – Mop Holder – Reference Drawings for Locations Basis of Design: Bradley Accessories; Model 9984 36" wide unit
- D. "5" – Garment Hook – Reference Drawings for locations Basis of Design: Stainless Steel Double Robe Hook Unit
- E. "6b" - Soap Dispenser – Reference Drawings for locations Basis of Design: Bradley Accessories; Model 6562 Satin SS Finish
- F. "7b" – Toilet Paper Dispenser – (Wall / partition mount) – Unit when back to back must be through bolted through partition. o Basis of Design: Bradley Accessories; Model 5424 (Single Jumbo Roll) Satin Finish stain-less steel.

- G. "11a" – Hand Dryers – Reference Drawings for locations and Electrical Drawings for Power Basis of Design: Excel Dryer, Inc. - ThinAir Hand Dryer – Brushed Stainless Steel Electrical Coordination Requirements – Provide 110 - 120V unit
- H. "13a" – Feminine Product Vendor – Reference Drawings for locations. Basis of Design: Bradley Accessories; Model 4017
- I. "13b" – Feminine Product Disposal – Reference Drawings for locations. Basis of Design: Bradley Accessories; Model 4722-15
- J. "20" Baby Changing Tables
 - 1. BOD: Koala Care Baby Changing Station KB-300
 - 2. Color: Polyethylene Gray
- K. ADA Locker Room Benches – SALISBURY WOOD ADA LOCKER BENCH 42"W x 18"H x 20"D MODEL #77781-ADA-LGT
 - 1. OR APPROVED EQUAL
 - a. Size: ADA 20"x42" Wood Locker Room Bench
 - b. Height: 18" Tall
 - c. 4 pedestal legs floor mounted
 - d. Leg Color: Black

2.6 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.
- B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
- B. Grab Bars: Install to withstand a downward load of at least 250 lbf, when tested according to ASTM F 446.

3.2 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Remove temporary labels and protective coatings.
- C. Clean and polish exposed surfaces according to manufacturer's written recommendations.

END OF SECTION 102800

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SECTION 104413 - FIRE PROTECTION CABINETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Fire-protection cabinets for the following:
 - a. Portable fire extinguishers.

1.3 PREINSTALLATION CONFERENCE

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to fire-protection cabinets including, but not limited to, the following:
 - a. Schedules and coordination requirements.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing recessed-, semirecessed-, or surface-mounting method and relationships of box and trim to surrounding construction.
- B. Shop Drawings: For fire-protection cabinets. Include plans, elevations, sections, details, and attachments to other work.
- C. Samples: For each type of exposed finish required.
- D. Samples for Initial Selection: For each type of exposed finish required.
- E. Samples for Verification: For each type of exposed finish required, prepared on Samples 6 by 6 inches square.

- F. Product Schedule: For fire-protection cabinets. Indicate whether recessed, semirecessed, or surface mounted. Coordinate final fire-protection cabinet schedule with fire-extinguisher schedule to ensure proper fit and function.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For fire-protection cabinets to include in maintenance manuals.

1.6 COORDINATION

- A. Coordinate size of fire protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
- B. Coordinate sizes and locations of fire protection cabinets with wall depths.

1.7 SEQUENCING

- A. Apply decals or vinyl lettering on field-painted fire-protection cabinets after painting is complete.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E 814 for fire-resistance rating of walls where they are installed.

2.2 FIRE PROTECTION CABINET

- A. Cabinet Type: Suitable for fire extinguisher.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. J. L. Industries, Inc.;
 - b. Larsen's Manufacturing Company;
 - c. Potter Roemer LLC;
- B. Cabinet Construction: Nonrated.
 - 1. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.0428-inch- thick, cold-rolled steel sheet lined with minimum 5/8-inch- thick, fire-barrier material. Provide factory-drilled mounting holes.

- C. Cabinet Material: Cold-rolled steel sheet.
 - 1. Shelf: Same metal and finish as cabinet.
- D. 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.
- E. Cabinet Trim Material: Same material and finish as door.
- F. Door Material: Steel sheet.
- G. Door Style: Full acrylic bubble with frame.
- H. Door Glazing: Molded acrylic bubble.
 - 1. Acrylic Bubble Color: Clear transparent.
- I. 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 door pull and friction latch.
 - 2. Provide continuous hinge, of same material and finish as trim, permitting door to open 180 degrees.
- J. Accessories:
 - 1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
 - 2. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated.
 - a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."
 - 1) Location: Applied to location indicated on Drawings.
 - 2) Application Process: Silk-screened.
 - 3) Lettering Color: As indicated.
 - 4) Orientation: As indicated on Drawings.
- K. Materials:
 - 1. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.

- a. Finish: Baked enamel or powder coat.
- b. Color: As selected by Architect from full range of industry colors and color densities.

2.3 FABRICATION

- A. Fire Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
 - 1. Weld joints and grind smooth.
 - 2. Provide factory-drilled mounting holes.
 - 3. Prepare doors and frames to receive locks.
 - 4. 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. Miter and weld perimeter door frames.
- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.4 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
- C. Finish fire-protection cabinets after assembly.
- D. Appearance of Finished Work: Noticeable variations in same piece are 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 walls and partitions for suitable framing depth and blocking where semi-recessed cabinets will be installed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare recesses for semi-recessed fire-protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

- A. General: Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.
- B. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.
- C. Identification: Apply decals or vinyl lettering at locations indicated.

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 104413

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SECTION 104416 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

1.3 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.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.
- B. Product Schedule: For fire extinguishers. Coordinate final fire-extinguisher schedule with fire-protection cabinet schedule to ensure proper fit and function.

1.5 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.7 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire protection cabinets to ensure fit and function.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

- 1. Failures include, but are not limited to, the following:
 - a. Failure of hydrostatic test according to NFPA 10.
 - b. Faulty operation of valves or release levers.
- 2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each fire protection cabinet and mounting bracket indicated.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Amerex Corporation.
 - b. Ansul Incorporated; Tyco International Ltd.
 - c. Badger Fire Protection; a Kidde company.
 - d. Buckeye Fire Equipment Company.
 - e. Fire End & Croker Corporation.
 - f. J. L. Industries, Inc.; a division of Activar Construction Products Group.
 - g. Larsen's Manufacturing Company.
 - h. Potter Roemer LLC.

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:60-B:C, 10-lb nominal capacity, with mono-ammonium phosphate-based dry chemical in enameled-steel container.

2.3 MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Amerex Corporation.
 - b. Ansul Incorporated; Tyco International Ltd.
 - c. Badger Fire Protection; a Kidde company.
 - d. Buckeye Fire Equipment Company.
 - e. Fire End & Croker Corporation.
 - f. J. L. Industries, Inc.; a division of Activar Construction Products Group.
 - g. Larsen's Manufacturing Company.
 - h. Potter Roemer LLC.
- B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
 - a. Orientation: As indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fire extinguishers for proper charging and tagging.
1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
 - 1. Mounting Brackets: 54 inches above finished floor to top of fire extinguisher.
- B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION 104416

SECTION 105113 - LOCKERS

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. Lockers for Men's and Women's Locker Rooms

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal locker and bench.
- B. Shop Drawings: For metal lockers. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Show locker trim and accessories.
 - 2. Include locker identification system and numbering sequence.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Samples for Verification: For metal lockers in manufacturer's standard sizes.
- E. Qualification Data: For qualified Installer.
- F. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.
- G. Warranty: Sample of special warranty.

1.4 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 metal lockers and accessories from single source from single manufacturer.
- C. Regulatory Requirements: Where metal lockers are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities" and] ICC/ANSI A117.1.
- D. Preinstallation Conference: Conduct conference at Project site.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver metal lockers until spaces to receive them are clean, dry, and ready for their installation.

1.6 PROJECT CONDITIONS

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

1.7 COORDINATION

- A. Coordinate sizes and locations of concrete bases for metal lockers.
- B. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections to ensure that metal lockers can be supported and installed as indicated.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal lockers that fail in materials or workmanship, excluding finish, within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures.
 - b. Faulty operation of latches and other door hardware.
 - 2. Locker manufacturer shall warrant the lockers for the lifetime use of the original purchaser from date of shipment. Warranty shall include all defects in material and workmanship, excluding finish, vandalism and improper installation.

PART 2 - PRODUCTS

2.1 STANDARD METAL LOCKERS (Locker Rooms)

- A. Manufacturers: Provide lockers produced by DeBourgh Manufacturing. Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. DeBorough Manufacturing – APEX Slope Top
 - 2. Penco Products, Inc..
 - 3. ASI Storage Solutions Inc.;
 - 4. Lyon Workspace Products, LLC;
 - 5. Republic Storage Systems Company;
- B. Locker Construction: APEX by DeBourgh
 - 1. Lockers to be welded unibody construction with exposed welds sanded smooth.
 - 2. No bolts, screws or rivets used in assembly of locker units.
 - 3. Ship lockers set-up, ready to be anchored in place in accordance with manufacturer's instructions.
 - 4. Size:
 - a. Standard: 1-Tier, 12"x18"x48" tall
 - b. ADA: 1-Tier, 12"x18"x48" tall
- C. Body of Lockers
 - 1. Sides and Intermediate Partitions: Exterior sides constructed of 16 gauge domestic cold rolled sheet steel for maximum durability with 18 gauge intermediate partitions. Intermediate partitions to be diamond perforated for maximum ventilation
 - 2. Backs: Solid sheet of 18 gauge cold rolled sheet steel welded to frames of sides and intermediate partitions.
 - 3. Shelves and Tier Dividers: Constructed of 18 gauge cold rolled sheet steel welded to sides and intermediate partition construction. Shelves provided in lockers 60-inches and taller, located to provide a minimum of 12-inches clearance.
- D. Continuous Door Strike
 - 1. Tier dividers, tops and bottoms constructed to provide four-sided, continuous door strike for a secure, sanitary and intrusion-free locker while door is in closed position.
- E. Doors
 - 1. Doors are 14 gauge CRS formed outer panel with double bends on both sides and a single bend on top and bottom with 18 gauge steel formed stiffener panel.
 - 2. Door stiffener runs top to bottom on hinge side of door and is securely welded to outer door to form a reinforced channel for additional torque-free strength and sound reduction when closing door. (Inner panel not available on 9-inch wide or box locker 12-inches high or less).

F. Door Ventilation

1. Diamond Perforated with ½-inch by 1-3/8-inch diamond perforations providing 37% ventilation per square inch. Perforate entire door panel.

G. Latching

1. Sentry III Single-Point Latch
 - a. 11 gauge stationary latch welded securely to locker frame.
 - b. Latch extends no more than 1-1/4-inch into locker opening, penetrating through cup.
 - c. Flush-mounted, recessed stainless steel cup in a formed door with 18 gauge vertical back panel stiffener.

H. Hinges

1. 16 gauge continuous piano hinge on the right side of the opening.
2. Hinges welded to door and riveted to locker frame.

I. Filler Panels: Manufacturer's standard fabricated from 18 gauge solid steel finished to match lockers.

J. Finish

1. Complete locker unit to be thoroughly cleaned, phosphatized and sealed.
2. Finish to be baked powder coat with a minimum 2-3 mil thickness.
3. Color of lockers shall be chosen from manufacturer's full range of colors.
4. Locker body to be a separate color from perforated door panels.

K. Hooks

1. Hooks to be heavy duty forged steel with ball ends and zinc plated.
2. Provide two single ceiling hooks and one double ceiling hook in each locker opening 20-inches or taller.

L. Numbering

1. Furnish each locker with black anodized laser-etched aluminum number plate.
2. Locate number plate near center of each door.
3. Owner to furnish numbering sequence.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls, floors, and support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install level, plumb, and true; shim as required, using concealed shims.
 - 1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches o.c. Using concealed fasteners, install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion.
 - 2. Anchor single rows of metal lockers to walls near top and bottom of lockers of lockers and to floor.
- B. Knocked-Down Metal Lockers: Assemble with standard fasteners, with no exposed fasteners on door faces or face frames.
- C. Equipment and Accessories: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.
 - 1. Attach hooks with at least two fasteners.
 - 2. Attach door locks on doors using security-type fasteners.
 - 3. Identification Plates: Identify metal lockers with identification indicated on Drawings.
 - a. Attach plates to each locker door, near top, centered, with at least two aluminum rivets.

3.3 ADJUSTING, CLEANING, AND PROTECTION

- A. Clean, lubricate, and adjust hardware. Adjust doors and latches to operate easily without binding.
- B. Protect metal lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit use during construction.
- C. Touch up marred finishes, or replace metal lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION 105113

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SECTION 123610 - FIXED AUDIENCE SEATING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Fixed upholstered chairs with self-rising seat mechanisms, aisle and intermediate standards.
 - 1. Typical applications include the following:
 - A. Riser mounted chairs.
 - 2. Special applications include the following:
 - A. Arc Com Industries, Inc – Fabric Selections
 - B. Five (5) year manufacturer's warranty
 - C. Basebid: Lifetime warranty on high density cast aluminum stanchions and seat return
 - D. Alternate: Irwin 5 year warranty
 - E. Contoured foam back panel (3" thick lumbar)
 - F. High density cast aluminum stanchions with nylon accent axis and footcaps coordinated to match or contrast arm's seat, bottom, and outer back.
 - G. Certified independent testing laboratory results for B 1-3 will be required.
 - H. Seat foam options
- B. Related Sections:
 - 1. Division 16 Electrical sections for electrical wiring and connections for aisle lights.

1.2 REFERENCES

- A. American Welding society (AWS):
 - 1. AWS D1.1 Structural Welding Code - Steel.
 - 2. AWS D1.3 Structural Welding Code - Sheet Steel.
- B. American Institute of Steel Construction (AISC):
 - 1. AISC - Design of Hot Rolled Steel Structural Members.
- C. American National Standards Institute (ANSI).
- D. American Iron & Steel Institute (AISI):
 - 1. AISI - Design Cold Formed Steel Structural Members.
- E. Aluminum Association (AA):
 - 1. AA - Aluminum Structures, Construction Manual Series.
- F. American Society for Testing Materials (ASTM)
 - 1. ASTM - Standard Specification for Properties of Materials.
- G. National Forest Products Association (NFPA):
 - 1. NFPA - National Design Specification for Wood Construction.
- H. National Bureau of Standards/Products Standard (NBS/PS):
 - 1. PS1 - Construction and Industrial Plywood.
- I. Americans with Disability Act (ADA)

1. ADA - Standards for Accessible Design.

1.3 MANUFACTURER'S SYSTEM ENGINEERING DESCRIPTION

- A. Structural Performance: Engineer, fabricate and install fixed audience seating to the following structural loads without exceeding allowable design working stresses of materials involved, including anchors and connection. Apply each load to produce maximum stress in each respective component of each audience seat unit.
- B. Manufacturer's System Design Criteria:
 - 1. Seats and Backs:
 - A. Shall embody a timeless sculptured appearance to harmonize with any architectural form or room decor.
 - B. Shall exhibit moderate compound contours for supportive comfort avoiding excess anatomical pressures.
 - C. Seat shall be semi-cantilevered, self-centering, automatic three-quarter (3/4) lift with over center retract feature, for ease of passage and janitorial access.
 - D. Seat shall be tested and professionally certified through an independent testing laboratory to support and withstand an evenly distributed 600 lb. static load without failure or irregularities that would impair usefulness.
 - E. Self-lifting seat shall be tested and professionally certified through an independent testing laboratory to withstand 350,000 operating cycles without failure of seat mechanism or measurable component wear.
 - F. Seat shall be tested and professionally certified to withstand 10,000 impacts of a 40 lb. sandbag dropped on the center of the seat from each of the following heights: 6", 8", 10", and 12". The rate of impacts shall be approximately 18 per minute with the total quantity of impacts equaling 40,000.
 - G. Back shall withstand an evenly distributed front or rear static load of 450 lbs.
 - H. Back shall be tested and professionally certified to withstand, without failure, 40,000 swinging impacts each to the front and rear of the back by means of two opposing 40 lb. sandbags. The sandbags shall be moved horizontally and equally for 10,000 cycles each at the following distances of 6", 8", 10", and 12" at a rate of 35 cycles per minute.
 - I. Back shall withstand, without failure, an evenly distributed Horizontal Traverse Static Load of 200 lbs. The load shall be applied to the top of the back at a 45-degree angle to the row of seats.
 - J. Armrests shall be tested and professionally certified to withstand, without failure, a 200 lb. static load applied both perpendicular to and vertically down on the arm.
 - 2. Materials (Flammability) shall satisfy applicable test, codes, standards, or requirements as follows:
 - A. Copolymer polypropylene shall have a burn rate of 1 inch [25.4mm] or less per ASTM 635.
 - B. Upholstery materials shall meet requirements as set forth in the state of California Bureau of Home Furnishings Technical Bulletin 117.
 - C. Fire-performance Characteristics of Seat Padding: Provide seating that complies with test method: California Technical Bulletin 117

- D. Cushioning and padding shall be self-extinguishing as defined in the requirements as set forth in the State of California Bureau of Home Furnishings Technical Bulletin 117.

1.4 SUBMITTALS

- A. Section Cross-Reference: Submit required submittals in accordance with "Conditions of the Contract" and Division
 - 1. General Requirements sections of this "Project Manual."
- B. Project Data: Manufacturer's product data for each system. Include the following:
 - 1. Project list: Ten (10) seating projects of similar size, complexity and in service for at least five (5) years.
 - 2. Deviations: List of deviations from these project specifications.
- C. Shop Drawings: Indicate fixed upholstered chair seating layout. Show all equipment to be furnished with details of accessories to be supplied including necessary electrical service to be provided by others.
- D. Samples: Seat materials and color finish as selected by Architect from manufacturers standard color finishes.
- E. Manufacturer Qualifications: Certification of insurance coverage and manufacturing experience of manufacturer.
- F. Installer Qualifications: Installer qualifications indicating capability, experience, and manufacturer acceptance.
- G. Engineer Qualifications: Certification by a professional engineer registered in the state of manufacturer that the equipment to be supplied meets or exceeds the design criteria of this specification.
- H. Owners Manuals: Provide Owner's maintenance manual and demonstrate operating procedures.
- I. Warranty: Manufacturers standard five-year warranty documents.

1.5 QUALITY ASSURANCE

- A. Welding Standards & Qualification: Comply with AWS D1.1 Structural Welding Code - Steel and AWS D1.3 Structural Welding Code - Sheet Steel.
- B. Insurance Qualifications: Mandatory that each bidder submit with his bid an insurance certificate from the manufacturer evidencing the following insurance coverage:
 - 1. Workers Compensation - including Employers Liability with the following limits:
 - A. \$500,000.00 Each Accident
 - B. \$500,000.00 Disease - Policy Limit
 - C. \$500,000.00 Disease - Each Employee
 - 2. Commercial General Liability - including premises/ operations, independent contractors and products completed operations liability. Limits of liability shall not be less than \$2,000,000.00

- C. Manufacturer Qualifications: Manufacturer who has 10 years of experience manufacturing spectator seating equipment.
- D. Installer Qualifications: Engage experienced Installer who has specialized in installation of audience seating similar to types required for this project and who is acceptable to, or certified by, fixed upholstered chair seating manufacturer.
- E. Engineer Qualifications: Engage professional licensed engineer experienced in providing engineering services of the kind indicated that have resulted in the successful installation of audience seating similar in material, design, fabrication, and extent to those types indicated for this project.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver fixed upholstered chair seating in manufacturers packaging clearly labeled with manufacturer name and content.
- B. Handle seating equipment in a manner to prevent damage.
- C. Deliver the seating at a scheduled time for installation that will not interfere with other trades operating in the building.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Coordinate actual dimensions of construction affecting fixed upholstered chair seating installation by accurate field measurements before fabrication. Show recorded measurements on final shop drawings. Coordinate field measurements and fabrication schedule with construction progress to avoid delay of Work.

1.8 WARRANTY

- A. Manufacturer's Product Warranty: Submit manufacturer's standard warranty form for fixed upholstered chairs. This warranty is in addition to, and not a limitation of other rights Owner may have under Contract Documents.
 - 1. Warranty Period: Five years from Date of Substantial Completion.
 - 2. Warranty Period: Lifetime warranty on high density cast aluminum stanchions and seat return.
 - 3. Beneficiary: Issue warranty in legal name of project Owner.
 - 4. Warranty Acceptance: Owner is sole authority who will determine acceptance of warranty documents.

1.9 MAINTENANCE AND OPERATION

- A. Instructions: An owner's manual shall be transmitted to the Owner by the manufacturer of the seating or his representative.
- B. Service: Maintenance and operation of the seating system shall be the responsibility of the Owner or his duly authorized representative, and shall include the following:
 - 1. Only attachments specifically approved by the manufacturer for the specific installation shall be attached to the seating.
 - 2. Periodic annual inspections and required maintenance of each seating system shall be performed according to the owners manual to assure safe conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. SEATING BASE BID

1. Manufacturer: Hussey Seating Company, U.S.A.
2. Address: 38 Dyer St Ext., North Berwick, Maine, 03906
3. Telephone: (207) 676-2271; Fax: (207) 676-9690
4. email: info@hussyseating.com
5. Product: Hussey Quattro Chair System
 - A. Model: QUATTRO
 - B. Series: Classic
 - C. Back Foam: 3" Contoured
 - D. Seat Type: Upholstered
 - E. Armrest Type: Plastic – Graphite
 - F. Standards: Cast aluminum
 - G. Chair Mount: Floor Mount
 - H. End Panels: Laminate – Monticello Maple
6. Product Description/Criteria: SEE DRAWINGS
7. Product Accessories: ADA standards (Easy Access), Chair numbers (Brass Tone), Row letters (Brass Tone)
8. Upholstery
 - A. Base Bid: Designtex
 - ~~B. ST1 - Samba 2654-804 Noir~~
 - NOT USED AT DHMS OR BHMS
 - C. ST2 - Samba 2654-603 Fig
 - USED AT BOTH DHMS AND BHMS
9. ATTIC STOCK – Provide 7 Additional Chairs per Middle School at the discretion and suggestion of Seat Supplier. Architect and owner to confirm types and final stock provided.

B. ALTERNATE #2 – Seating Manufacturer Alternate

1. Manufacturer: Irwin Seating Company
 - A. Model: Citation Model #90.12.10.4
 - B. Back Foam: 2" Foam and I Piece Fabric Tailoring
 - C. Seat Type: Upholstered
 - D. Standards: Heavy Gauge Steel
 - E. Chair Mount: Floor Mount
 - F. End Panels: Laminate – Monticello Maple
2. Product Accessories: ADA standards (Easy Access), Chair numbers (Brass Tone), Row letters (Brass Tone)
3. Upholstery
 - A. Base Bid: Designtex
 - ~~B. ST1 - Samba 2654-804 Noir~~
 - NOT USED AT DHMS OR BHMS
 - C. ST2 - Samba 2654-603 Fig

- *USED AT BOTH DHMS AND BHMS*
- 4. *ATTIC STOCK – Provide 7 Additional Chairs per Middle School at the discretion and suggestion of Seat Supplier. Architect and owner to confirm types and final stock provided.*

C. Other Acceptable Manufacturers:

1. A substitute manufacturer not meeting or exceeding the basis of design will not be considered.

2.2 MATERIALS

- A. Cast Aluminum: AA - 380
- B. Steel Tubing: ASTM A513
- C. Steel Sheet/Coil: ASTM A607
- D. Mechanical or Adhesive Concrete Anchors: SAE grade 2
- E. Exposed Hardwood Lumber: Wood Species: Birch
- F. Concealed Plywood: Engineered Wood Association PS1-95 2000: Poplar
- G. Exposed Plywood: Hardwood Plywood ANSI/HPVA-1 2000: Birch
- H. Medium Density Fiberboard: ANSI A208-2-1986
- I. Plastic Laminate: NEMA LD3.1-1985, GP 48
- J. Polyurethane Foam Padding: ASTM D-3574
- K. Molded plastic: Injection Molded copolymer polypropylene or nylon 6/6.

2.3 DESIGN AND CONCEPT:

Auditorium chairs shall be designed to exhibit a modern appearance that will enhance any auditorium's décor. Seats, backs, and standards shall complement each other without the need for end panels or other adornments. Superior comfort will be derived through careful ergonomic engineering, selection of materials, and design of supportive structures.

2.4 FABRICATION

A. Upholstered Seats:

1. The seat assembly shall consist of a stylish padded and upholstered top surface, a polypropylene bottom shell with dual contours, and a dual sprung lifting mechanism. Seat shall have the ability to achieve a full fold position when rearward pressure is applied. Superior comfort shall be derived through careful ergonomic engineering.
2. Upholstery Pad: The upholstered seat topper shall consist of a 5/8" thick formed ply form base with contoured molded polyurethane foam padding and fabric upholstered cover. Seat padding shall be properly contoured to support the body without causing discomfort. The upholstered seat cover shall exhibit a high degree of tailoring and will be affixed to the base with upholstery staples.

3. **Seat Mechanism:** Seat lifting mechanism shall use lubricated lifting springs to provide whisper quiet fail-safe operation. The seat structure shall rotate on a 3/4" [19mm] spanner bar to assure shaft alignment and eliminate binding due to irregular floor conditions. Seats shall be certified to withstand 350,000 lifting cycles and a 600lb static load without failure.
4. **Standard Bottom Cover:** Seat shell/bottom shall be constructed of polypropylene plastic to provide a durable yet aesthetic design. The cover shall protect the mechanical parts of the lifting hinge and upholstered seat topper. The shell / bottom shape shall compliment the overall design of the chair.
5. **SEAT FOAM OPTION:** Ultra Plush seat foam.
6. **SEAT COVER TAILORING:** Waterfall

B. Classic Series Back

1. The outer back panel shall be constructed of injection molded polypropylene Plastic. The panel shall be no less than 27" in length and conceal the rear and sides of the upholstered inner panel. The panel shall extend below the rear of the seat to protect the chair occupant's back.
2. The inner upholstered panel shall be 5/8" 11 ply thick-formed hardwood with an ergonomically engineered contour. The wings for attachment of chair back to standard shall be not less than 14 ga and will be attached via concealed fasteners. Wings shall position the chair back at one of three positions: 15, 18, or 21 degrees. There shall be no exposed fasteners above the seat. Chair back upholstery shall exhibit a high degree of workmanship and customization.
 - A. **Soft Square - 33":** The top corners of the back are conically shaped for stylish looks and a timeless appearance. Overall back height is 33" above the floor allowing proper shoulder support of the chair occupant. The back surface shall be contoured to facilitate proper posture of a seated individual.
3. **BACK FOAM TYPE:** Contoured Foam.
4. **BACK COVER TAILORING:** Upholstered

C. Cast Aluminum Standards:

1. Standards shall be die cast Aluminum AA380 grade or Irwin heavy gauge steel see ALTERNATE #1
2. Standards shall be floor attached.
3. Cast Aluminum Standards shall be an integral aesthetic part of the chair's appearance and do not require the use of end panels unless in case of ALTERNATE #1

D. Seat Hinges:

1. Seat hinges shall be fully contained within the seat pan and fitted with a pair of independent [nylon bushings](#).
2. Each of the independent seat hinges shall be fitted with double acting; self-centering, pre-loaded coiled seat return spring.

3. Seat hinge and spring installation shall be designed not to require periodic adjustment or lubrication.

E. Finish:

1. Finish for Steel / Aluminum Components: (Indoor) Material shall be pre-treated in an iron phosphate wash system prior to finish application. Finish shall be a specially blended polyester T.G.I.C./Epoxy powder coating with a minimum dry film thickness of 1.5 mils. Color to be selected from Manuf. Standard Range.
2. Injection molded polypropylene or nylon: Shall be pigmented, in one of manufacturers standard colors and have a textured surface.
3. Fabric: Samba 2654-603 Fig
4. Color: Shall be per manufacturer's standards. Seating Contractor shall submit color samples for owner's approval prior to manufacture.

F. Armrests:

1. Armrests, Injection Molded Plastic: Armrests shall be of injection molded, textured polypropylene. Armrest to be secured to standard with concealed fasteners.

2.5 FASTENINGS

A. Chair Assembly

1. All welds shall be made at the factory by welders that are certified on the equipment and process used.
2. All structural connections shall be made with S.A.E. stress rated zinc plated or, black oxide steel bolts, washers and nuts.

B. Concrete Floor Attachment

1. Chair stanchions shall each be attached by means of two 3/8"[10mm] threaded rods secured into concrete with a fast curing acrylic adhesive. Adhesive and rods are set in holes drilled to a minimum depth of 2 1/2"[64mm] in the concrete.
ALTERNATE #1: Attach Using 2 x 1/4" CEB or Hilti Kwikbold Achors per Stanchion.
2. Threaded rods shall be of approved type with zinc-plate finish or made of stainless steel to suit environmental conditions.
3. Acrylic Adhesive shall be in conformance with ASTM Type IV, Grade 3, and covered by ICBO evaluation.
4. Stanchion to be placed on the bolts, stanchions to be permanently secured with a flat washer, lock washer and nut.

2.6 ACCESSORIES

- A. Brass Chair Numbers: Black text with brass background on a 23/32" x 2 7/32" elliptical aluminum plate. Plate fitted in a vandal resistant recess located in front edge of plastic seat cover and secured with two aluminum pop rivets.
- B. Brass Row Letters: Black text with brass background on a 23/32" x 2 7/32" elliptical aluminum plate. Plate fitted in a vandal resistant recess located in rear of armrest and secured by means of two mechanical fasteners.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Verify areas to receive fixed upholstered chair seating are free of impediments interfering with installation and condition of installation substrates are acceptable to receive audience seats in accordance with seating manufacturer's recommendations. Do not commence installation until conditions are satisfactory.

3.2 INSTALLATION

- A. Manufacturer's Recommendations: Comply with seating manufacturer's recommendations for product installation requirements.
- B. General: Install fixed upholstered chair system in accordance with manufacturer's installation instructions and final shop drawings. Provide accessories, anchors, fasteners, inserts and other items for installation of seating and for permanent attachment to adjoining construction.

3.3 ADJUSTMENT AND CLEANING

- A. Adjustment: After installation completion, all equipment is to be adjusted for smooth and proper operation.
- B. Cleaning: Clean work area and remove debris from site.

3.4 PROTECTION

- A. General: Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer to ensure audience seats are without damage or deterioration at time of substantial completion.

END OF SECTION

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SECTION 123623 - PLASTIC-LAMINATE-CLAD COUNTERTOPS

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 plastic-laminate countertops.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product, including high-pressure decorative laminate, adhesive for bonding plastic laminate and fire-retardant-treated materials.
 - 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: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
 - 1. Show locations and sizes of cutouts and holes for plumbing fixtures faucets and other items installed in plastic-laminate countertops.
 - 2. Apply AWI Quality Certification Program label to Shop Drawings.
- C. Samples for Initial Selection:
 - 1. Plastic laminates.
- D. Samples for Verification:
 - 1. Plastic laminates, 8 by 10 inches, for each type, color, pattern, and surface finish, with one sample applied to core material and specified edge material applied to one edge.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For the following:

1. High-pressure decorative laminate.
2. Adhesives.

C. Evaluation Reports: For fire-retardant-treated materials, from ICC-ES.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
- B. Installer Qualifications: Fabricator of products.
- C. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install countertops until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 degrees F and relative humidity between 25 and 55 percent during the remainder of the construction period.
- B. Field Measurements: Where countertops are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Established Dimensions: Where countertops are indicated to fit to other construction, establish dimensions for areas where countertops are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 PLASTIC-LAMINATE COUNTERTOPS

- A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades indicated for construction, installation, and other requirements.
 - 1. Provide labels from AWI certification program indicating that countertops, including installation, comply with requirements of grades specified.
 - 2. The Contract Documents contain selections chosen from options in the quality standard and additional requirements beyond those of the quality standard. Comply with those selections and requirements in addition to the quality standard.
- B. Grade: Custom.
- C. High-Pressure Decorative Laminate: NEMA LD 3, Grade HGS.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Formica Corporation.
 - b. Lamin-Art, Inc.
 - c. Panolam Industries International, Inc.
 - d. Wilsonart International; Div. of Premark International, Inc.
- D. 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:
- E. Edge Treatment: 3mm edge band.
- F. Core Material: Exterior-grade plywood.
- G. Core Material at Sinks: Exterior-grade plywood.
- H. Core Thickness: 3/4 inch.
 - 1. Build up countertop thickness to 1-1/2 inches at front, back, and ends with additional layers of core material laminated to top.
- I. Backer Sheet: Provide plastic-laminate backer sheet, NEMA LD 3, Grade BKL, on underside of countertop substrate.
- J. Paper Backing: Provide paper backing on underside of countertop substrate.

2.2 WOOD MATERIALS

- A. Wood Products: Provide materials that comply with requirements of referenced quality standard unless otherwise indicated.

1. Wood Moisture Content: 5 to 10 percent.

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. Fire-Retardant-Treated Materials, General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
 1. Use treated materials that comply with requirements of referenced woodworking 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-Treated Lumber and Plywood: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
 1. Kiln dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.
 2. For items indicated to receive a stained or natural finish, use organic resin chemical formulation.
 3. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking shop certified by testing and inspecting agency.
 4. Mill lumber before treatment and implement special procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.

2.4 ACCESSORIES

- A. Grommets for Cable Passage through Countertops: 2-inch OD, black, molded-plastic grommets and matching plastic caps with slot for wire passage.

2.5 MISCELLANEOUS MATERIALS

- A. Adhesives: Do not use adhesives that contain urea formaldehyde.

- B. Adhesive for Bonding Plastic Laminate: Unpigmented contact cement.

- 1. Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified above for faces.

2.6 FABRICATION

- A. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.

- B. Fabricate countertops to dimensions, profiles, and details indicated. Provide front and end overhang of 1 inch over base cabinets. Ease edges to radius indicated for the following:

- 1. Solid-Wood (Lumber) Members: 1/16 inch unless otherwise indicated.

- C. 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.

- 1. Notify Architect seven days in advance of the dates and times woodwork fabrication will be complete.
 - 2. 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.

- D. 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.

- 1. Seal edges of openings in countertops with a coat of varnish.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

- A. Grade: Install countertops to comply with same grade as item to be installed.
- B. 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.
 - 2. Seal edges of cutouts by saturating with varnish.
- C. 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 plastic-laminate countertops with concealed clamping devices located within 6 inches of front and back edges and at intervals not exceeding 24 inches. Tighten according to manufacturer's written instructions to exert a constant, heavy-clamping pressure at joints.
- D. Install countertops level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches.
- E. Scribe and cut countertops to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- F. 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.
- G. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
 - 1. Install countertops with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
 - 2. If not integral part of top; secure backsplashes to tops with concealed metal brackets at 16 inches o.c. and to walls with adhesive.
 - 3. Seal junctures of tops, splashes, and walls with mildew-resistant silicone sealant or another permanently elastic sealing compound recommended by countertop material manufacturer.

3.3 ADJUSTING AND CLEANING

- A. Repair damaged and defective countertops, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.

- B. Clean countertops on exposed and semiexposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 123623

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SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Copper tube and fittings.
 - 2. Piping joining materials.

1.3 INFORMATIONAL SUBMITTALS

- A. System purging and disinfecting activities report.
- B. Field quality-control reports.

1.4 FIELD CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
 - 1. Notify Construction Manager and Owner no fewer than ten (10) days in advance of proposed interruption of water service.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

- B. Potable-water piping, and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."
- C. Comply with NSF Standard 372 for low lead.

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
- B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- D. Copper Unions:
 - 1. MSS SP-123.
 - 2. Cast-copper-alloy, hexagonal-stock body.
 - 3. Ball-and-socket, metal-to-metal seating surfaces.
 - 4. Solder-joint or threaded ends.
- E. Copper Pressure-Seal-Joint Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. NIBCO INC.
 - c. Viega LLC.
 - 2. Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
 - 3. Fittings for NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

- C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- F. Install piping to permit valve servicing.
- G. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- K. Install sleeves for piping penetrations of walls, ceilings, and floors.
- L. Install sleeve seals for piping penetrations of concrete walls and slabs.
- M. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.2 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

3.3 FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.

- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
1. Vertical Piping: MSS Type 8 or 42, clamps.
 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support vertical piping and tubing at base and at each floor.
- C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 5. NPS 3: 10 feet with 1/2-inch rod.
- E. Install supports for vertical copper tubing every 10 feet.
- F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2: 10 feet with 3/8-inch rod.
 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 5. NPS 3: 12 feet with 1/2-inch rod.
- G. Install supports for vertical steel piping every 15 feet.
- H. Support piping and tubing not listed in this article according to MSS SP-58 and manufacturer's written instructions.

3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - 1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 - 2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
 - 3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.6 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section "Mechanical Identification".
- B. Label pressure piping with system operating pressure.

3.7 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Piping Inspections:
 - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
 - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
 - c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

- a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
 - f. Prepare reports for tests and for corrective action required.
- B. Domestic water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.8 ADJUSTING

- A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
 2. Open shutoff valves to fully open position.
 3. Open throttling valves to proper setting.
 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.9 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction.
- B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.10 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Aboveground domestic water piping, NPS 2 1/2 and smaller, shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
 2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
- D. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
 2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

3.11 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
 - 2. Hot-Water Circulation Piping, Balancing Duty: Thermostatic balancing valves.
 - 3. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION

SECTION 221118 - PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Vacuum breakers.
2. Balancing valves.
3. Temperature-actuated, water mixing valves.
4. Strainers.
5. Hose bibbs.
6. Wall hydrants.
7. Drain valves.
8. Water-hammer arresters.
9. Flexible connectors.
10. Cleanouts.
11. Miscellaneous sanitary drainage piping specialties.
12. Floor Drains

B. Related Requirements:

1. Section 230519 "Meters and Gages" for thermometers, pressure gages, and flow meters in domestic water piping.
2. Section 221116 "Domestic Water Piping" for water meters.
3. Section 224400 "Plumbing Fixtures" for water tempering equipment.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For domestic water piping specialties.
 1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Potable-water piping, and components shall comply with NSF 61 Annex G and NSF 14.

2.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. WATTS.
 - c. Zurn Industries, LLC.
 - 2. Standard: ASSE 1001.
 - 3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
 - 4. Body: Bronze.
 - 5. Inlet and Outlet Connections: Threaded.
 - 6. Finish: Rough bronze.
- B. Hose-Connection Vacuum Breakers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIFAB, Inc.
 - b. WATTS.

- c. Woodford Manufacturing Company.
 - d. Zurn Industries, LLC.
- 2. Standard: ASSE 1011.
 - 3. Body: Bronze, nonremovable, with manual drain.
 - 4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
 - 5. Finish: Chrome or nickel plated.

2.4 BALANCING VALVES

A. Thermostatic Balancing Valves:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Therm OmegaTech
 - b. Jomar Valve
- 2. Despeciation: Circuit Solver shall regulate the flow of recirculated domestic hot water based on water temperature entering Circuit Solver regardless of system operating pressure. When fully closed-circuit Solver shall bypass a minimum flow to maintain dynamic control of the recirculating loop and provide a means for system sanitizing.
- 3. Circuit Solver shall be factory adjustable from 105F (40.5C) to 140F (60C) as required by project conditions. (Other set points available, consult factory) a. Circuit Solver shall modulate between open and closed position within a 10F (5.5C) range.
- 4. Circuit Solver shall be available in sizes ranging from ½ inch NPT to 2" NPT.
- 5. Circuit Solver body and all internal components shall be constructed of stainless steel with major components constructed of type 303 stainless steel. A. Circuit Solver sizes ½ inch through 2-inch shall be rated to 200 PSIG maximum working pressure.
- 6. All Circuit Solvers shall be standard tapered female pipe thread, NPT.
- 7. All Circuit Solvers shall be rated to 300F (148.9C) maximum working temperature.
- 8. Circuit Solver shall be ANSI/AWWA C800 compliant.
- 9. All Circuit Solvers shall be NSF-61 compliant with zero lead content for use in all domestic water systems.
- 10. Thermal actuator shall be spring operated and self-cleaning, delivering closing thrust sufficient to keep orifice opening free of scale deposits.
- 11. Thermal actuator shall be rated for a minimum of 200,000 cycles.
- 12. Installation of Circuit Solver shall be made by qualified tradesmen. Install Circuit Solver in each domestic hot water return piping branch beyond last hot water device in that branch. A. Provide suitable line size isolation valves, unions, and other components as indicated in piping detail shown on the drawings.

2.5 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Individual-Fixture, Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Lawler Manufacturing Company, Inc.
 - b. Leonard Valve Company.
 - c. POWERS; A WATTS Brand.
2. Standard: ASSE 1016, thermostatically controlled, water tempering valve.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
4. Body: Bronze body with corrosion-resistant interior components.
5. Temperature Control: Adjustable.
6. Inlets and Outlet: Threaded.
7. Finish: Rough or chrome-plated bronze.
8. Tempered-Water Setting: 105 deg F.

2.6 HOSE BIBBS

A. Hose Bibbs HB-1:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Rough bronze.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Operating key.
12. Operation for Service Areas: Wheel handle.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.7 WALL HYDRANTS

A. Nonfreeze Wall Hydrants WH-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIFAB, Inc.
 - b. Jay R. Smith Mfg. Co.

- c. Woodford Manufacturing Company.
 - d. Zurn Industries, LLC.
- 2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
 - 3. Pressure Rating: 125 psig.
 - 4. Operation: Loose key.
 - 5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
 - 6. Inlet: NPS $\frac{3}{4}$.
 - 7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
 - 8. Box: Deep, flush mounted with cover.
 - 9. Box and Cover Finish: Polished nickel bronze.
 - 10. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
 - 11. Nozzle and Wall-Plate Finish: Polished nickel bronze.
 - 12. Operating Keys(s): Two with each wall hydrant.

2.8 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

- 1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
- 2. Pressure Rating: 400-psig minimum CWP.
- 3. Size: NPS $\frac{3}{4}$.
- 4. Body: Copper alloy.
- 5. Ball: Chrome-plated brass.
- 6. Seats and Seals: Replaceable.
- 7. Handle: Vinyl-covered steel.
- 8. Inlet: Threaded or solder joint.
- 9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.9 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters WHA:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIFAB, Inc.
 - b. Jay R. Smith Mfg. Co.
 - c. Zurn Industries, LLC.
- 2. Standard: ASSE 1010 or PDI-WH 201.
- 3. Type: Metal bellows.
- 4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.10 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flex Pression Ltd.
 - 2. Flex-Hose Co., Inc.
 - 3. Metraflex Company (The).
- B. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
 - 1. Working-Pressure Rating: Minimum 200 psig.
 - 2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
 - 3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

2.11 CLEANOUTS

- A. Cast-Iron Exposed Cleanouts CO:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIFAB, Inc.
 - b. Jay R. Smith Mfg. Co.
 - c. Zurn Industries, LLC.
 - 2. Standard: ASME A112.36.2M.
 - 3. Size: Same as connected drainage piping
 - 4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch Hubless, cast-iron soil pipe test tee as required to match connected piping.
 - 5. Closure: Countersunk or raised-head, cast-iron plug.
 - 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
- B. Cast-Iron Exposed Floor Cleanouts FCO:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIFAB, Inc.
 - b. Jay R. Smith Mfg. Co.
 - c. Zurn Industries, LLC.
 - 2. Standard: ASME A112.36.2M for adjustable housing cleanout.
 - 3. Size: Same as connected branch.
 - 4. Type: Adjustable housing.
 - 5. Body or Ferrule: Cast iron.

6. Clamping Device: Not required.
7. Outlet Connection: Inside calk Spigot.
8. Closure: Brass plug with straight threads and gasket.
9. Adjustable Housing Material: Cast iron Plastic with threads.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Medium Duty.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts WCO:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIFAB, Inc.
 - b. Jay R. Smith Mfg. Co.
 - c. Zurn Industries, LLC.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure Plug:
 - a. Brass.
 - b. Countersunk or raised head.
 - c. Drilled and threaded for cover attachment screw.
 - d. Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
7. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

2.12 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
 - a. NPS 2: 4-inch-minimum water seal.
 - b. NPS 2-1/2 and Larger: 5-inch-minimum water seal.

B. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

2.13 FLOOR AND ROOF DRAINS

A. Cast-Iron Floor Drains FD-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIFAB, Inc.
 - b. Jay R. Smith Mfg. Co.
 - c. Zurn Industries, LLC.
2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Seepage Flange: Not required.
6. Anchor Flange: Not required.
7. Clamping Device: Required.
8. Outlet: Bottom.
9. Backwater Valve: Not required.
10. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel.
11. Sediment Bucket: Not required.
12. Top or Strainer Material: Bronze.
13. Top of Body and Strainer Finish: Nickel bronze.
14. Top Shape: Round.
15. Funnel: Not required.
16. Trap Pattern: Deep-seal P-trap.
17. Trap Features: Trap-seal primer valve drain connection (As Required).

2.14 WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:

- a. Strainers NPS 2 and Smaller: 0.033 inch.
 - b. Strainers NPS 2-1/2 to NPS 4: 0.062 inch.
 - c. Strainers NPS 5 and Larger: 0.125 inch.
6. Drain: Factory-installed, hose-end drain valve.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 - 1. Locate backflow preventers in same room as connected equipment or system.
 - 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
- B. Install balancing valves in locations where they can easily be adjusted.
- C. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
- D. Install water-hammer arresters in water piping according to PDI-WH 201.
- E. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- F. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- G. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- H. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
 - 3. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.

- c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
- 4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.
 - a. Maintain integrity of waterproof membranes where penetrated.
- 5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

3.2 LABELING AND IDENTIFYING

- A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 230553 "Mechanical Identification."

3.3 FIELD QUALITY CONTROL

- A. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- B. Prepare test and inspection reports.

3.4 ADJUSTING

- A. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipe, tube, and fittings.
 - 2. Specialty pipe fittings.
- B. Related Requirements:
 - 1. Divisions 31, 32 and 33 for specifications sections related to site utility installation.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 FIELD CONDITIONS

- A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Construction Manager Owner no fewer than two days in advance of proposed interruption of sanitary waste service.
 - 2. Do not proceed with interruption of sanitary waste service without Architect's Construction Manager's Owner's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.

2.2 PIPING MATERIALS

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Heavy-Duty, Hubless-Piping Couplings:
 - 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. ANACO-Husky.
 - b. Charlotte Pipe and Foundry Company.
 - c. MIFAB, Inc.
 - d. Tyler Pipe; a subsidiary of McWane Inc.
 - 2. Standards: ASTM C 1277 and ASTM C 1540.
 - 3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 PVC PIPE AND FITTINGS

- A. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.
- B. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- C. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.

- D. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- E. Adhesive Primer: ASTM F 656.
- F. Solvent Cement: ASTM D 2564.

2.5 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

- 1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- 2. Unshielded, Nonpressure Transition 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) Fernco Inc.
 - 2) Froet Industries LLC.
 - 3) Mission Rubber Company, LLC; a division of MCP Industries.
 - b. Standard: ASTM C 1173.
 - c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. End Connections: Same size as and compatible with pipes to be joined.
 - e. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

B. Dielectric Fittings:

- 1. Dielectric Unions:
 - 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) A.Y. McDonald Mfg. Co.
 - 2) WATTS.
 - 3) Wilkins.
 - 4) Zurn Industries, LLC.

b. Description:

- 1) Standard: ASSE 1079.
- 2) Pressure Rating: 125 psig minimum at 180 deg F.
- 3) End Connections: Solder-joint copper alloy and threaded ferrous.

2. Dielectric Flanges:

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) WATTS.
- 2) Wilkins.
- 3) Zurn Industries, LLC.

b. Description:

- 1) Standard: ASSE 1079.
- 2) Factory-fabricated, bolted, companion-flange assembly.
- 3) Pressure Rating: 125 psig minimum at 180 deg F.
- 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

PART 3 - EXECUTION

3.1 EARTH MOVING

- A. Provide all excavating, trenching, bedding and cover materials, rough grading and final grading for underground sanitary waste and vent piping. Comply with all related Division 31 and 32 Sections.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
 2. 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. Do not install PVC piping in Plenum rates ceiling space.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
 - 1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
 - 2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drainpipe.
 - a. Straight tees, elbows, and crosses may be used on vent lines.
 - 3. Do not change direction of flow more than 90 degrees.
 - 4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
 - a. Reducing size of waste piping in direction of flow is prohibited.
- L. Lay buried building waste piping beginning at low point of each system.
 - 1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
 - 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 - 3. Maintain swab in piping and pull past each joint as completed.
- M. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.

2. Horizontal Sanitary Waste Piping: 2 percent downward in direction of flow.
 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- O. Install steel piping according to applicable plumbing code.
- P. Install underground PVC piping according to ASTM D 2321.
- Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- R. Install sleeves for piping penetrations of walls, ceilings, and floors.
- S. Install sleeve seals for piping penetrations of concrete walls and slabs.
- T. Install escutcheons for piping penetrations of walls, ceilings, and floors.
- U. Provide continuous underground pipe markers using detectable warning tape with aluminum backing, continuously printed with "Caution Buried Sewer Line Below" in black lettering on a green background, minimum 6 inches wide by 5 mil thick, manufactured for direct burial service.
- 3.3 JOINT CONSTRUCTION
- A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.
- C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- D. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 appendixes.
- 3.4 SPECIALTY PIPE FITTING INSTALLATION
- A. Transition Couplings:
1. Install transition couplings at joints of piping with small differences in ODs.

2. In Waste Drainage Piping: Unshielded Shielded, nonpressure transition couplings.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hanger and support devices and installation specified in Section 230529 "Hangers and Supports."
 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 3. Vertical Piping: MSS Type 8 or Type 42, clamps.
 4. Install individual, straight, horizontal piping runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 5. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 6. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 2. NPS 3: 60 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
 5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
 6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.

2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.

- H. Install supports for vertical PVC piping every 48 inches.
- I. Support piping and tubing not listed above according to MSS SP-58 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect waste and vent piping to the following:
1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
 5. Equipment: Connect waste piping as indicated.
 - a. Provide shutoff valve if indicated and union for each connection.
 - b. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- E. Make connections according to the following unless otherwise indicated:
1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.7 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping.

3.8 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
 - a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
 - a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
 - b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
 - c. Inspect joints for leaks.
 - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.
 - a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
 - b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.

- c. Air pressure must remain constant without introducing additional air throughout period of inspection.
 - d. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.9 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.
- D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.
- E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.10 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping shall be the following:
 - 1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
- C. Aboveground, vent piping shall be the following:
 - 1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
- D. Non-plenum rated toilet chases, soil, waste, and vent piping shall be any of the following:
 - 1. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
- E. Underground, soil, waste, and vent piping shall be any of the following:
 - 1. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

SECTION 221413 - STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipe, tube, and fittings.
 - 2. Specialty pipe fittings.
- B. Related Requirements:
 - 1. Divisions 31, 32 and 33 for specifications sections related to site utility installation.

1.3 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Storm Drainage Piping: 10-foot head of water.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.7 PROJECT CONDITIONS

- A. Interruption of Existing Storm-Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of storm-drainage service.
 - 2. Do not proceed with interruption of storm-drainage service without Construction Manager's and Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Heavy-Duty, Hubless-Piping Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ANACO-Husky.
 - b. Charlotte Pipe and Foundry Company.
 - c. MIFAB, Inc.
 - d. Tyler Pipe; a subsidiary of McWane Inc.
 - 2. Standards: ASTM C 1277 and ASTM C 1540.
 - 3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

- C. Adhesive Primer: ASTM F 656.
- D. Solvent Cement: ASTM D 2564.

2.4 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
3. Unshielded, Nonpressure Transition 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) Fernco Inc.
 - 2) Mission Rubber Company, LLC; a division of MCP Industries.
 - 3) Plastic Oddities.
 - b. Standard: ASTM C 1173.
 - c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
4. Shielded, Nonpressure Transition 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) Cascade Waterworks Mfg. Co.
 - 2) Mission Rubber Company, LLC; a division of MCP Industries.
 - b. Standard: ASTM C 1460.

- c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Dielectric Fittings:

- 1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- 2. Dielectric Unions:
 - 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) Matco-Norca.
 - 2) WATTS.
 - 3) Zurn Industries, LLC.
 - b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Pressure Rating: 150 psig at 180 deg F.
 - 3) End Connections: Solder-joint copper alloy and threaded ferrous.
- 3. Dielectric Flanges:
 - 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) Matco-Norca.
 - 2) WATTS.
 - 3) Zurn Industries, LLC.
 - b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Factory-fabricated, bolted, companion-flange assembly.
 - 3) Pressure Rating: 150 psig.
 - 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

PART 3 - EXECUTION

3.1 EARTH MOVING

- A. Provide all excavating, trenching, bedding and cover materials, rough grading and final grading for underground storm drainage piping. Comply with all related Division 31 and 32 Sections.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from 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. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- K. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

- L. Install storm drainage piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Storm Drain: 1 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.
- M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- N. Install steel piping according to applicable plumbing code.
- O. Install aboveground PVC piping according to ASTM D 2665.
- P. Install underground PVC piping according to ASTM D 2321.
- Q. Plumbing Specialties:
 - 1. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
- R. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- S. Install sleeves for piping penetrations of walls, ceilings, and floors.
- T. Install sleeve seals for piping penetrations of concrete walls and slabs.
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230513 "Basic Mechanical Materials and Methods."
- V. Provide continuous underground pipe markers using detectable warning tape with aluminum backing, continuously printed with "Caution Buried Sewer Line Below" in black lettering on a green background, minimum 6 inches wide by 5 mil thick, manufactured for direct burial service.

3.3 JOINT CONSTRUCTION

- A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Hub-and-Spigot, Cast-Iron Soil Piping Calked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.
- C. Hubless, Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

- D. Plastic, Non-Pressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendices.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Drainage Piping: Unshielded, non-pressure transition couplings.
3. In Aboveground Force-Main Piping: Fitting-type transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 VALVE INSTALLATION

A. General valve installation requirements are specified in Section 230523 "General Duty Valves."

B. Shutoff Valves: Install shutoff valve on each sump pump discharge.

1. Install gate or full-port ball valve for piping NPS 2 and smaller.
2. Install gate valve for piping NPS 2-1/2 and larger.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
3. Vertical Piping: MSS Type 8 or Type 42, clamps.
4. Individual, Straight, Horizontal Piping Runs:

- a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
5. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 6. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 2. NPS 3: 60 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. Install supports for vertical PVC piping every 48 inches.
- H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.
1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- E. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

- A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Section 230553 "Mechanical Identification"

3.9 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 3. Test Procedure: Test storm drainage piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
 4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 5. Prepare reports for tests and required corrective action.

3.10 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.11 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground storm drainage piping shall be the following:
 - 1. Hubless, cast-iron soil pipe and fittings; heavy-duty, hubless-piping couplings; and coupled joints.
- C. Underground storm drainage piping shall be any of the following:
 - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 2. Dissimilar Pipe-Material Couplings: Unshielded, non-pressure transition couplings.

END OF SECTION

SECTION 224400 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Water closets.
 - 2. Urinals.
 - 3. Flushometer valves.
 - 4. Toilet seats.
 - 5. Lavatories.
 - 6. Lavatory Systems
 - 7. Water Coolers.
 - 8. Sinks
 - 9. Showers
 - 10. Faucets.
 - 11. Supports.
 - 12. Service Basin

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For flushometer valves to include in operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than six of each type.
 - 2. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
 - 3. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 WALL-MOUNTED WATER CLOSETS

- A. Water Closets WC-1: Wall mounted, top spud.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard America.
 - b. Kohler Co.
 - c. Zurn Industries, LLC.
 - 2. Bowl:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Material: Vitreous china.
 - c. Type: Siphon jet.
 - d. Style: Flushometer valve.
 - e. Height: Standard.
 - f. Rim Contour: Elongated.
 - g. Water Consumption: 1.28 gal. per flush.
 - h. Spud Size and Location: NPS 1-1/2; top.
 - 3. Flushometer Valve: FV-1.
 - 4. Toilet Seat: WCS.
 - 5. Support: Water closet carrier.
 - 6. Water-Closet Mounting Height: Standard.
- B. Water Closets WC-2: Wall mounted, top spud, accessible.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard America.

- b. Kohler Co.
 - c. Zurn Industries, LLC.
2. Bowl:
- a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Material: Vitreous china.
 - c. Type: Siphon jet.
 - d. Style: Flushometer valve.
 - e. Height: Standard.
 - f. Rim Contour: Elongated.
 - g. Water Consumption: 1.6 gal. per flush.
 - h. Spud Size and Location: NPS 1-1/2; top.
3. Flushometer Valve: FV-1.
4. Toilet Seat: WCS.
5. Support: Water closet carrier.
6. Water-Closet Mounting Height: Handicapped/elderly according to ICC/ANSI A117.1.

2.2 WALL-MOUNTED URINALS

A. Urinals U-1: Wall hung, back outlet, washout.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard America.
 - b. Kohler Co.
 - c. Zurn Industries, LLC.
- 2. Fixture:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Material: Vitreous china.
 - c. Type: Washout with extended shields.
 - d. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
 - e. Water Consumption: Low.
 - f. Spud Size and Location: NPS 3/4, top.
 - g. Outlet Size and Location: NPS 2, back.
 - h. Color: White.
- 3. Flushometer Valve: FV-2
- 4. Waste Fitting:
 - a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
 - b. Size: NPS 2.

5. Support: Type I Urinal Carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture.
6. Urinal Mounting Height: Standard.

B. Urinals U-2: Wall hung, back outlet, washout, accessible.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard America.
 - b. Kohler Co.
 - c. Zurn Industries, LLC.
2. Fixture:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Material: Vitreous china.
 - c. Type: Washout with extended shields.
 - d. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
 - e. Water Consumption: Low.
 - f. Spud Size and Location: NPS 3/4, top.
 - g. Outlet Size and Location: NPS 2, back.
 - h. Color: White.
3. Flushometer Valve: FV-2
4. Waste Fitting:
 - a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
 - b. Size: NPS 2.
5. Support: Type I Urinal Carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture.
6. Urinal Mounting Height: Handicapped/elderly according to ICC A117.1.

2.3 FLUSHOMETER VALVES

A. Solenoid-Actuator, Diaphragm Flushometer Valves FV-1:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Sloan Valve Company.
 - b. Zurn Industries, LLC.
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.

6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Panel Finish: Chrome plated or stainless steel.
8. Style: Exposed.
9. Actuator: Solenoid complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
10. Trip Mechanism: Hard-wired electronic sensor complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
11. True Manual Override: Required.
12. Transformers: Required.
13. Consumption: 1.6 gal. per flush.
14. Minimum Inlet: NPS 1.
15. Minimum Outlet: NPS 1-1/4.

B. Solenoid-Actuator, Diaphragm Flushometer Valves FV-2:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Sloan Valve Company.
 - b. Zurn Industries, LLC.
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Panel Finish: Chrome plated or stainless steel.
8. Style: Exposed.
9. Actuator: Solenoid complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
10. Trip Mechanism: Hard-wired electronic sensor complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
11. True Manual Override: Required.
12. Transformers: Required.
13. Consumption: 1.0 gal. per flush.

C. Toilet Seats WCS:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Church Seats; Bemis Manufacturing Company.
 - b. Kohler Co.
 - c. Olsonite Seat Co.
 - d. Zurn Industries, LLC.

2. Standard: IAPMO/ANSI Z124.5.
3. Material: Plastic.
4. Type: Commercial (Standard).
5. Shape: Elongated rim, open front.
6. Hinge: Check.
7. Hinge Material: Noncorroding metal.
8. Seat Cover: Required.
9. Color: White.

2.4 SUPPORTS

A. Water Closet Carrier:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. J.R. Smith.
 - b. Watts.
 - c. Zurn Industries, LLC.
2. Standard: ASME A112.6.1M.
3. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

B. Type I Urinal Carrier:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. J.R. Smith.
 - b. Watts.
 - c. Zurn Industries, LLC.
2. Standard: ASME A112.6.1M.

C. Type II Lavatory Carrier:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg. Co.
 - b. Watts,
 - c. Zurn Industries, LLC.

D. Type II Water Cooler Carrier:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg. Co.
 - b. Watts.
 - c. Zurn Industries, LLC.
2. Standard: ASME A112.6.1M.

2.5 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

A. Lavatory L-1: Vitreous china, wall mounted, with back, accessible.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard America.
 - b. Kohler Co.
 - c. Mansfield Plumbing Products LLC.
 - d. Zurn Industries, LLC.
2. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: For wall hanging.
 - c. Nominal Size: Oval, 20 by 18 inches.
 - d. Faucet-Hole Punching: One hole.
 - e. Faucet-Hole Location: Top.
 - f. Color: White.
 - g. Mounting Material: Chair carrier.
3. Faucet: LF
4. Support: Type II, concealed-arm lavatory carrier.
5. Lavatory Mounting Height: Handicapped/elderly according to ICC A117.1.
6. Supply Fittings:
 - a. Standard: ASME A112.18.1/CSA B125.1.
 - b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.
 - 1) Operation: Loose key.
 - 2) Risers: NPS 1/2, chrome-plated, rigid-copper pipe.
7. Waste Fittings:
 - a. Standard: ASME A112.18.2/CSA B125.2.
 - b. Trap(s):

- 1) Size: NPS 1-1/2.
 - 2) Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch-thick brass tube to wall; and chrome-plated brass or steel wall flange.
 - 3) Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch-thick stainless-steel tube to wall; and stainless-steel wall flange.
- c. Continuous Waste:
- 1) Size: NPS 1-1/2.
 - 2) Material: Chrome-plated, 0.032-inch-thick brass tube.
8. Pipe Shield: Required, PVC Resign.

2.6 SOLID-BRASS, AUTOMATICALLY OPERATED LAVATORY FAUCETS

- A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.
- B. Lavatory Faucets LF: Automatic-type, hard-wired, battery back-up, electronic-sensor-operated, mixing, solid-brass valve.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Chicago Faucets; Geberit Company.
 - b. Sloan Valve Company.
 - c. Zurn Industries, LLC.
 2. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
 3. 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.
 4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punching; coordinate outlet with spout and fixture receptor.
 5. Body Type: Single hole.
 6. Body Material: Commercial, solid brass.
 7. Finish: Polished chrome plate.
 8. Maximum Flow Rate: 0.5 gpm.
 9. Mounting Type: Deck, exposed.
 10. Spout: Rigid type.
 11. Spout Outlet: Aerator.
 12. Back-up system: Battery.
 13. Drain: Not part of faucet.
 14. Transformer: Required.

2.7 SOLID SURFACE, LAVATORY SYSTEMS

A. Lavatory System LS-1: Solid Surface, 3-station receptor with infrared sensor actuator.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bradley Corporation.
 - b. Willoughby Industries.
2. Standard: IAPMO IGC 156.
3. 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.
4. Receptor:
 - a. Standard: ICPA SS-1 for solid-surface receptor.
 - b. Height to Rim: Handicapped/elderly according to ICC A117.1.
 - c. Color or Finish: By Architect.
 - d. Drain: Grid with 1 ½" tailpiece.
5. Faucet: Hard-wired integral spay nozzle.
6. Thermostatic Mixing Valve: Required.
7. Liquid-Soap Dispensers: Manual, for each user station.
8. Pedestal: Stainless steel with access panel.
9. Supply Fittings:
 - a. Piping: NPS 1/2 copper tubing.
 - b. Valves: Shutoff valve on each supply.
 - c. Supply Piping: From top.
10. Waste Fittings:
 - a. Standard: ASME A112.18.2/CSA B125.2.
 - b. Trap and Drain Piping: (2) NPS 1 1/2.
 - c. Vent Piping: NPS 1-1/2 to ceiling.
11. Shroud: Stainless steel.
12. Mounting: Wall

2.8 PRESSURE WATER COOLERS

A. Pressure Water Coolers EWC-1: Bi-level wall mounted, standard, wheelchair accessible.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Elkay Manufacturing Co.
 - b. Halsey Taylor.
 - c. Haws Corporation.
2. Standards:
 - a. Comply with NSF 61 Annex G.
 - b. Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.
3. Cabinet: Bi-level with two attached cabinets, vinyl-covered steel with stainless-steel top.
4. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
5. Control: Sensor
6. Drain: Grid with NPS 1-1/4 tailpiece.
7. Supply: NPS 3/8 with shutoff valve.
8. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 brass P-trap.
9. Bottle Filler: Sensor activated, hands free activation.
10. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
11. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
 - a. 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.
12. Capacities and Characteristics:
 - a. Cooled Water: 8 gph.
 - b. Ambient-Air Temperature: 90 deg F.
 - c. Inlet-Water Temperature: 80 deg F.
 - d. Cooled-Water Temperature: 50 deg F.
 - e. Electrical Characteristics:
 - 1) Volts: 120-V ac.
 - 2) Phase: Single.
 - 3) Hertz: 60.
 - 4) Full-Load Amperes: 4.0.
 - 5) Minimum Circuit Ampacity: 370 Watts.
13. Support: Type II Water Cooler Carrier.
14. Water Cooler Mounting Height: Handicapped/elderly according to ICC A117.1.

2.9 SERVICE BASINS

A. Service Basins MR-1: Terrazzo, floor mounted.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company.
2. Fixture:
 - a. Standard: IAPMO PS 99.
 - b. Shape: Radial front.
 - c. Nominal Size: 36 by 24 inches.
 - d. Height: 12 inches with dropped front.
 - e. Tiling Flange: On two sides.
 - f. Rim Guard: On front top surfaces.
 - g. Color: Not applicable.
 - h. Drain: Grid with NPS 3 outlet.
3. Mounting: On floor and flush to wall.
4. Faucet: SF-2.

2.10 SHOWER FAUCETS

A. NSF Standard: Comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects," for shower materials that will be in contact with potable water.

B. Shower Faucets SH-1: Shower and hand shower system, accessible.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Symmons.
 - b. Bradley.
 - c. Powers.
2. Description: Concealed thermostatic water mixing valve. Cast brass body, integral check stops, brass faceplate, lever type handle and fixed and handheld showerhead.
3. Faucet:
 - a. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016.
 - b. Body Material: Solid brass.
 - c. Finish: Polished chrome plate.
 - d. Shower-Arm, Flow-Control Fitting: 1.5 gpm.
 - e. EPA WaterSense: Required.
 - f. Mounting: Concealed.
 - g. Operation: Single-handle, twist or rotate control.

- h. Antiscald Device: Integral with mixing valve.
 - i. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
- 4. Supply Connections: NPS 1/2.
- 5. Shower Head:
 - a. Standard: ASME A112.18.1/CSA B125.1.
 - b. Type: Showerhead and hand shower system.
 - c. Shower Head Material: Metallic with chrome-plated finish.
 - d. Spray Pattern: Adjustable.
 - e. Integral Volume Control: Required.
 - f. Shower-Arm, Flow-Control Fitting: 2.0 gpm.
 - g. Temperature Indicator: Integral with faucet.

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 water-closet installation.
- B. Examine walls and floors for suitable conditions where water closets will be installed.
- C. Examine counters and walls for suitable conditions where lavatories will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Water-Closet Installation:
 - 1. Install level and plumb according to roughing-in drawings.
 - 2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
 - 3. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.
- B. Support Installation:
 - 1. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
 - 2. Use carrier supports with waste-fitting assembly and seal.
 - 3. Install floor-mounted, back-outlet water closets attached to building floor substrate, onto waste-fitting seals; and attach to support.
 - 4. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.

C. Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
4. Install actuators in locations that are easy for people with disabilities to reach.
5. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

D. Install toilet seats on water closets.

E. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

F. Joint Sealing:

1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to water-closet color.
3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

G. Lavatory Installation:

1. Install lavatories level and plumb according to roughing-in drawings.
2. Install supports, affixed to building substrate, for wall-mounted lavatories.
3. Indicate on Drawing those lavatories that are required to be accessible.
4. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.
5. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
6. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
7. Indicate on Drawings those lavatories that are required to be accessible.
8. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 CONNECTIONS

- A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to water closets, allow space for service and maintenance.

3.4 ADJUSTING

- A. Operate and adjust water closets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.
- C. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

- A. Clean fixtures and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed fixtures and fittings.
- C. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 230130 - HVAC AIR DISTRIBUTION SYSTEM 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 existing supply air ducts serving the Drexel Hill Middle School Auditorium.

1.3 DEFINITIONS

- A. ACAC: American Council for Accredited Certification.
- B. AIHA-LAP: American Industrial Hygiene Association Lab Accreditation Program
- C. ASCS: Air systems cleaning specialist.
- D. CESB: Council of Engineering and Scientific Specialty Boards.
- E. CMI: Certified Microbial Investigator.
- F. CMR: Certified Microbial Remediator.
- G. EMLAP: Environmental Microbiology Laboratory Accreditation Program.
- H. IEP: Indoor Environmental Professional.
- I. IICRC: Institute of Inspection, Cleaning, and Restoration Certification.
- J. NADCA: National Air Duct Cleaners Association.

1.4 ACTION SUBMITTALS

- A. Product Data:
 - 1. Cleaning agents
 - 2. Antimicrobial surface treatments.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data:
 - 1. For an ASCS.

2. For a CMR.

B. Field Quality-Control Reports:

1. Project's existing conditions.
2. Evaluations and recommendations, including cleanliness verification.
3. Strategies and procedures plan.

1.6 CLOSEOUT SUBMITTALS

A. Post-Project report.

1.7 QUALITY ASSURANCE

A. ASCS Qualifications: A certified member of NADCA.

1. Certification: Employ an ASCS certified by NADCA.
2. Supervisor Qualifications: Certified as an ASCS by NADCA.

B. IEP Qualifications: CMI who is certified by ACAC and accredited by CESB.

C. CMR Qualifications: Certified by ACAC and accredited by CESB.

D. UL Compliance: Comply with UL 181 and UL 181A for fibrous-glass ducts.

E. Cleaning Conference: Conduct conference at Project site.

1. Review methods and procedures related to HVAC air-distribution system cleaning, including, but not limited to, review of the cleaning strategies and procedures plan.

PART 2 - PRODUCTS

2.1 HVAC CLEANING AGENTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. BBJ Environmental Solutions.
2. Goodway Technologies Corporation.
3. Nu-Calgon.

B. Description:

1. Formulated for each specific soiled coil condition that needs remedy.
2. Will not corrode or tarnish aluminum, copper, or other metals.

2.2 ANTIMICROBIAL SURFACE TREATMENT

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Bio-Cide International, Inc.
 - 2. Ecolab, Inc.
- B. Description: Specific product selected shall be as recommended by the IEP based on the specific antimicrobial needs of the specific Project conditions.
 - 1. Formulated to kill and inhibit growth of microorganisms.
 - 2. EPA-registered for use in HVAC systems and for the specific application in which it will be used.
 - 3. Have no residual action after drying, with zero VOC off-gassing.
 - 4. OSHA compliant.
 - 5. Treatment shall dry clear to allow continued visual observation of the treated surface.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Inspect HVAC air-distribution equipment, ducts, plenums, and system components to determine appropriate methods, tools, and equipment required for performance of the Work.
- B. Perform "Project Evaluation and Recommendation" according to NADCA ACR.
- C. Cleaning Plan: Prepare a written plan for air-distribution system cleaning that includes strategies and step-by-step procedures. At a minimum, include the following:
 - 1. Supervisor contact information.
 - 2. Work schedule, including location, times, and impact on occupied areas.
 - 3. Methods and materials planned for each HVAC component type.
 - 4. Required support from other trades.
 - 5. Equipment and material storage requirements.
 - 6. Exhaust equipment setup locations.
- D. Existing Conditions Report: Prepare a written report that documents existing conditions of the systems and equipment. Include documentation of existing conditions, including inspection results, photo images, laboratory results, and interpretations of the laboratory results by an IEP.
 - 1. Prepare written report listing conditions detrimental to performance of the Work.
- E. Proceed with work only after conditions detrimental to performance of the Work have been corrected.

- F. Use the existing service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry and for inspection.
- G. Comply with NADCA ACR, "Guidelines for Constructing Service Openings in HVAC Systems" Section.
- H. Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning.

3.2 CLEANING

- A. Comply with NADCA ACR, including items identified as "recommended," "advised," and "suggested."
- B. Perform electrical lockout and tagout according to Owner's standards or authorities having jurisdiction.
- C. Remove non-adhered substances and deposits from within the HVAC system.
- D. Systems and Components to Be Cleaned: All air-moving and -distribution equipment.
- E. Systems and Components to Be Cleaned
 - 1. Supply-air ducts serving the Drexel Hill Middle School Auditorium.
- F. Collect debris removed during cleaning. Ensure that debris is not dispersed outside the HVAC system during the cleaning process.
- G. Particulate Collection:
 - 1. For particulate collection equipment, include adequate filtration to contain debris removed. Locate equipment downwind and away from all air intakes and other points of entry into the building.
 - 2. HEPA filtration with 99.97 percent collection efficiency for particles sized 0.3 micrometer or larger shall be used where the particulate collection equipment is exhausting inside the building,
- H. Control odors and mist vapors during the cleaning and restoration process.
- I. Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning. Restore them to their marked position on completion of cleaning.
- J. System components shall be cleaned so that all HVAC system components are visibly clean. On completion, all components must be returned to those settings recorded just prior to cleaning operations.
- K. Clean all air-distribution devices, registers, grilles, and diffusers.
- L. Air-Distribution Systems:

1. Create service openings in the HVAC system as necessary to accommodate cleaning.
 2. Mechanically clean air-distribution systems specified to remove all visible contaminants, so that the systems are capable of passing the HVAC System Cleanliness Tests (see NADCA ACR).
- M. Debris removed from the HVAC system shall be disposed of according to applicable Federal, state, and local requirements.
- N. Mechanical Cleaning Methodology:
1. Source-Removal Cleaning Methods: The HVAC system shall be cleaned using source-removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and to safely remove these contaminants from the facility. No cleaning method, or combination of methods, shall be used that could potentially damage components of the HVAC system or negatively alter the integrity of the system.
 - a. Use continuously operating vacuum-collection devices to keep each section being cleaned under negative pressure.
 - b. Cleaning methods that require mechanical agitation devices to dislodge debris that is adhered to interior surfaces of HVAC system components shall be equipped to safely remove these devices. Cleaning methods shall not damage the integrity of HVAC system components or damage porous surface materials, such as duct and plenum liners.
 2. Cleaning Mineral-Fiber Insulation Components:
 - a. Fibrous-glass thermal or acoustical insulation elements present in equipment or ductwork shall be thoroughly cleaned with HEPA vacuuming equipment while the HVAC system is under constant negative pressure and shall not be permitted to get wet according to NADCA ACR.
 - b. Cleaning methods used shall not cause damage to fibrous-glass components and will render the system capable of passing the HVAC System Cleanliness Tests (see NADCA ACR).
 - c. Fibrous materials that become wet shall be discarded and replaced.
- O. Application of Antimicrobial Treatment:
1. Apply antimicrobial agents and coatings if active fungal growth is determined by the IEP to be at Condition 2 or Condition 3 status according to IICRC S520, as analyzed by a laboratory accredited by AIHA-LAP with an EMLAP certificate, and with results interpreted by an IEP. Apply antimicrobial agents and coatings according to manufacturer's written recommendations and EPA registration listing after the removal of surface deposits and debris.
 2. Apply antimicrobial treatments and coatings after the system is rendered clean.
 3. Apply antimicrobial agents and coatings directly onto surfaces of interior ductwork.
 4. Microbial remediation shall be performed by a qualified CMR.

3.3 CLEANLINESS VERIFICATION

- A. Verify cleanliness according to NADCA ACR, "Verification of HVAC System Cleanliness" Section.

- B. Verify HVAC system cleanliness after mechanical cleaning and before applying any treatment or introducing any treatment-related substance to the HVAC system, including biocidal agents and coatings.
- C. Surface-Cleaning Verification: Perform visual inspection for cleanliness. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and subjected to re-inspection for cleanliness.
- D. Prepare a written cleanliness verification report. At a minimum, include the following:
 - 1. Written documentation of the success of the cleaning.
 - 2. Site inspection reports, initialed by supervisor, including notation on areas of inspection, as verified through visual inspection.
 - 3. Surface comparison test results if required.
 - 4. Gravimetric analysis (nonporous surfaces only).
 - 5. System areas found to be damaged.
- E. Photographic Documentation: Provide photographic documentation upon completion of cleaning procedures.

3.4 RESTORATION

- A. Restore and repair HVAC air-distribution equipment, ducts, plenums, and components according to NADCA ACR, "Restoration and Repair of Mechanical Systems" Section.
- B. Restore service openings capable of future reopening.
- C. Remove fibrous-glass materials that cannot be restored by cleaning or resurfacing. Provide new duct wrap insulation according to Section 230713 "Duct Insulation."
- D. Replace damaged insulation according to Section 230713 "Duct Insulation."
- E. Ensure that closures do not hinder or alter airflow.
- F. New closure materials, including insulation, shall match opened materials and shall have removable closure panels fitted with gaskets and fasteners.
- G. Restore manual volume dampers and air-directional mechanical devices inside the system to their marked position on completion of cleaning.
- H. Measure air flows through air-distribution system.
- I. Measure static-pressure differential across each coil.

3.5 PROJECT CLOSEOUT

- A. Post-Project Report:
 - 1. Post-cleaning laboratory results if any.
 - 2. Post-cleaning photo images.

3. Post-cleaning verification summary.

B. Drawings:

1. Deviations of existing system from Owner's record drawings.
2. Location of service openings.

END OF SECTION 230130

SECTION 230511 - ELECTRICAL REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Electrical connections to equipment specified in Division 23.
 - 2. Motor starting equipment furnished by Division 23.
- B. Section does not include control wiring specifically detailed as part of the automatic temperature control system specified in Section 230900, HVAC Controls and Instrumentation.
- C. Refer to Section 230512 for Variable Frequency Motor Drives furnished by Division 23.

1.2 QUALITY ASSURANCE

- A. All motor starters and variable frequency drives for HVAC equipment that are not integral to units will be furnished by the HVAC Contractor and installed by the Electrical Contractor.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. NFPA Compliance: Air-handling units and ventilation systems and components shall be designed, fabricated, and installed in compliance with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."

1.3 COORDINATION

- A. Obtain and review shop drawings, product data, and equipment manufacturer's instructions for equipment furnished under Division 23.
- B. Obtain and review coordination drawings and determine connection locations and requirements.
- C. Sequence rough-in of electrical connections based on installation schedule and start-up schedule for equipment.

PART 2 - PRODUCTS

2.1 MOTORS

- A. All three phase motors shall NEMA rated premium efficiency.

- B. Motor enclosure shall be drip-proof or totally enclosed as required for the application. Totally enclosed motors shall have condensate drain holes for normal horizontal mounting.
- C. Bearings shall be anti-friction type, double shielded and rated for minimum life of 200,000 hours under normal operating conditions. External coating shall be an epoxy finish to further resist corrosion.
- D. Motors served by Variable Frequency Motor Drives shall be provided with factory installed Aegis Grounding Ring for Inverter / VFD Protection.

2.2 MOTOR STARTING EQUIPMENT

- A. Manufacturers: Subject to compliance with requirements, provide products by the following manufacturers:
 - 1. General Electric Company
 - 2. Siemens - ITE
 - 3. Square "D"
 - 4. Allen Bradley
 - 5. Eaton, Cutler Hammer
- B. Motor starters shall be three pole, 60 Hertz, full-voltage magnetic across the line type with NEMA 12 enclosures. For exterior, damp, or wet locations, enclosures shall be NEMA 3R raintight.
 - 1. Minimum size starter shall be NEMA size 0.
- C. Starters shall be of the combination thermal/magnetic circuit breaker type.
 - 1. The short circuit interrupting rating of the protective device provided shall be higher than the available system short circuit capacity at the point of connection and match the bus bracing withstand rating.
- D. Starter shall be furnished complete with "hand-off-automatic" selector switches, pilot indicating lights, a minimum of four auxiliary convertible contacts and fuses unless otherwise noted. Include other equipment as required and as necessary for proper power operation including but not limited to the following:
 - 1. Green pilot light for starter contacts "OPEN" or motor not running.
 - 2. Red pilot light for starter contacts "CLOSED" or motor running.
- E. Each magnetic starter shall have a 120-volt coil and a fuse for protection of control wiring. Each 208 or 480-volt starter shall have an individual control power transformer with primary and secondary fuses. Control power transformer shall have a VA rating sufficient to provide power for devices to be operated from transformer.
- F. Circuit protection shall be provided by Class K-5, dual element current limiting fuses for fused starters, except as specified for motor circuit fuses.
- G. Each starter shall be furnished complete with the proper quantity of ambient compensated thermal overload relays rated for the motor amperes. Overload relays,

used with power factor corrected motors, shall be selected to compensate for the reduced line current due to the capacitor.

- H. All magnetic starters shall be electrically held, and equipped with two (2) normally opened and two (2) normally closed auxiliary contacts.

2.3 MOTOR CIRCUIT FUSES

- A. Individual motor circuit fuses, rated 480 volts or less, shall be rated approximately 125 percent of motor full load current except where high ambient temperatures prevail or where the motor drives a heavy revolving part which cannot be brought up to full speed quickly, such as large fans. Under such conditions, the fuse should be 150 to 200 percent of motor full load current. UL Class RK1 or L. Bussman LPN-RK; LPS-RK; KRP-C.

2.4 THERMAL MANUAL MOTOR STARTING SWITCHES

- A. Thermal manual motor starting switches, for single phase motors, shall be manually operated toggle switches equipped with a melting alloy type thermal overload relay.
- B. Single phase motors, which are controlled by devices not rated for control of the motor, shall be provided with a magnetic starter as specified in this Section.
- C. Enclosures to be NEMA 1 for interior use and NEMA 3R raintight for exterior locations. Provide handle guard having locking provisions on enclosures. Provide flush mounted enclosures for units located in finished areas.
- D. Starting switches shall be combined with a three-position "hand-off-automatic" selector switch horsepower rated and a red pilot light mounted in the same enclosure.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that equipment is ready for electrical connection and wiring.

3.2 ELECTRICAL CONNECTIONS

- A. Comply with applicable requirements in Division 26 Sections for power wiring.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding."
- C. Make conduit connections to equipment using flexible conduit.
- D. All outdoor equipment shall be wired in weatherproof, sealtight cast boxes with rigid steel conduit. Provide flexible, sealtight conduit for final connection to equipment.
- E. Make electrical connections in accordance with equipment manufacturer's instructions.

- F. Tighten electrical connectors and terminals according to manufacturer's published torque tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- G. Make wiring connections using wire and cable with insulation suitable for temperatures encountered in heat producing equipment.
- H. Install disconnect switches, controllers, and control devices as indicated.
- I. Verify proper rotation of three-phase equipment.
- J. Extend power wiring, where applicable, through external disconnect switches, local control switches, remote mounted control panels, etc. and connect to terminal(s) in the equipment.
- K. Where applicable, extend wire and conduit between equipment and combination starter / disconnect switches.
- L. Provide identification labels on coverplates including circuit number.
- M. All panels, relays, terminal boxes, junction boxes, contactors, circuit breakers, safety switches, motor starters and similar items, shall be identified by name, function and/or control.

3.3 CONTRACTOR RESPONSIBILITIES

- A. Pumps
 - 1. Heating Coil Freeze Protection Pumps P-__: 120 volt – 1 phase. Disconnect switch for each pump shall be furnished by the HVAC Contractor. The Electrical Contractor shall mount the disconnect switch, wire through the disconnect switch and connect to the pump motor.
 - 2. All control wiring shall be provided by the ATC Contractor.
- B. Rooftop Dedicated Outdoor Air Handling Units (DOAS-) and Rooftop Air Handling Units with Packaged DX Cooling (RTU-)
 - 1. 208 volt – 3 phase
 - 2. Integral single point fused disconnect switch (NEMA 3R) shall be factory mounted and wired by the equipment manufacturer. Variable frequency drives (VFDs) for air handling units shall be factory mounted by the air handling unit manufacturer including wiring from drive to fan motor(s). The Electrical Contractor shall make a single-point field power connection.
 - 3. Air handling unit manufacturer shall provide factory mounted and factory wired 120-V GFI duplex receptacle with outlet disconnect switch in the unit control panel.
 - 4. The Electrical Contractor shall provide wiring from duct smoke detectors to fire alarm panel. The HVAC Contractor shall provide wiring from normally open auxiliary contact on duct smoke detectors to control circuitry for shut down of air handling unit if duct smoke detector is activated.
 - 5. All control wiring shall be provided by the ATC Contractor.

6. Where indicated on the drawings for units mounted on a dunnage frame, outdoor hot water piping shall have heat trace provided by the HVAC Contractor. The Electrical Contractor shall provide a dedicated 120-V power circuit (standby power) and terminate with a junction box mounted within the RTU control compartment. The HVAC Contractor shall make the final 120-V power connection for the piping heat trace circuit.

C. Cabinet Unit Heaters (Hot Water Coils)

1. 120 volt – 1 phase
2. Disconnect switch and power wiring provided by the Electrical Contractor.
3. All control wiring shall be provided by the ATC Contractor.

D. Ductless Split System Air Conditioning Units

1. 208 volt – 1 phase
2. Outdoor condensing unit power disconnect switch and indoor evaporator disconnect switch provided by the Electrical Contractor. The Electrical Contractor shall wire through both switches.
3. Indoor unit integral condensate pump shall be factory mounted and wired.
4. Battery powered drain pan level sensor shall be provided by the equipment manufacturer.
5. The HVAC Contractor shall install the equipment manufacturer's programmable thermostat and provide associated control wiring.
6. The ATC Contractor shall provide control wiring for a BAS space temperature sensor (monitoring only).

E. ATC Panels and Controls Transformers

1. 120 volt – 1 phase
2. The Electrical Contractor shall provide a dedicated 120-V power circuit and terminate with junction box. The ATC Contractor shall make the final 120-V power connections.
3. All control wiring shall be provided by the ATC Contractor.

F. Exhaust Fans, 120 volt – 1 phase

1. Integral disconnect switch factory mounted and wired by the equipment manufacturer. The Electrical Contractor shall make a single-point power connection.
2. All control wiring shall be provided by the ATC Contractor.

END OF SECTION 230511

SECTION 230512 - VARIABLE FREQUENCY MOTOR DRIVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. All Division 23 Specification Sections apply to this Section.

1.2 SUMMARY

- A. Section includes separately enclosed, preassembled, combination VFDs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.3 DEFINITIONS

- A. BAS: Building automation system.
- B. CPT: Control power transformer.
- C. DDC: Direct digital control.
- D. EMI: Electromagnetic interference.
- E. LED: Light-emitting diode.
- F. MCP: Motor circuit protector.
- G. NC: Normally closed.
- H. NO: Normally open.
- I. OCPD: Overcurrent protective device.
- J. PID: Control action, proportional plus integral plus derivative.
- K. PWM: Pulse width modulated.
- L. RFI: Radio-frequency interference.
- M. TDD: Total demand (harmonic current) distortion.

N. THD (V): Total harmonic voltage demand.

O. VFD: Variable-frequency motor drive.

1.4 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFD indicated.

1. Include dimensions and finishes for VFDs.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each VFD indicated.

1. Include 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. Source quality-control reports.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VFDs to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Division 01 "Operation and Maintenance Data," include the following:
 - a. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.
 - b. Manufacturer's written instructions for setting field-adjustable overload relays.
 - c. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
 - d. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
 - e. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.
 - f. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.6 QUALITY ASSURANCE

- A. All features shall be factory built and mounted. The entire assembly shall be factory tested.
- B. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to replace components of units that fail in materials or workmanship within specified warranty period including parts and labor.
 - 1. Full Unit Warranty – Two (2) years from Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Johnson Controls OEM – Danfoss Inc. or Eaton
 - 2. ABB.
 - 3. Danfoss Inc.
 - 4. Eaton

2.2 SYSTEM DESCRIPTION

- A. General Requirements for VFDs:
 - 1. VFDs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.
- B. Application: variable torque.
- C. VFD Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by a 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 inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
 2. 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 and blowers; 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 VFD input voltage rating.
 2. Input AC Voltage Unbalance: Not exceeding 5 percent.
 3. Input Frequency Tolerance: Plus or minus 5 percent of VFD frequency rating.
 4. Minimum Efficiency: 97 percent at 60 Hz, full load.
 5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or speed condition.
 6. Minimum Short-Circuit Current (Withstand) Rating: 65 kA.
 7. Ambient Temperature Rating: Not less than 14 deg F and not exceeding 104 deg F.
 8. Humidity Rating: Less than 95 percent (noncondensing).
 9. Altitude Rating: Not exceeding 3300 feet.
 10. Vibration Withstand: Comply with NEMA ICS 61800-2.
 11. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
 12. Speed Regulation: Plus or minus 5 percent.
 13. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
- G. Inverter Logic: Microprocessor based, isolated from all power circuits.
- H. Isolated Control Interface: Allows VFDs to follow remote-control signal over a minimum 40:1 speed range.
1. Signal: Electrical.
- I. 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 1800 seconds.
 4. Deceleration: 0.1 to 1800 seconds.
 5. Current Limit: 30 to minimum of 150 percent of maximum rating.
- J. Self-Protection and Reliability Features:

1. Surge Suppression: Factory installed as an integral part of the VFD, complying with UL 1449 SPD, Type 1 or Type 2.
 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.
 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. Phase imbalance protection.
 10. Reverse-phase protection.
 11. Short-circuit protection.
 12. Motor-temperature fault.
- K. Automatic Reset/Restart: Attempt up to five 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. In cases of severe trips, as a safety feature, the drive's input power may have to be cycled to restart a fault.
- L. Bidirectional Autospeed 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.
- M. 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.
- N. 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.
- O. Integral Input Disconnecting Means and OCPD: UL 489, thermal-magnetic circuit breaker with pad-lockable, door-mounted handle mechanism.
1. Contactor bypass shall be provided that allows operation of the motor via line power in the event of a failure of the VFD. Motor control selection shall be through either a VFD output contactor or a bypass contactor that is interlocked to ensure that both contactors are not energized simultaneously.
 2. Main input disconnect shall be provided that removes power from both the bypass and VFD.
 3. VFD-only, fast acting input fuses shall be provided.
 4. Overload protection shall be supplied in bypass mode.

- a. Adjustable current setting for complete motor protection when operating on line power.
 - b. Overload protection shall include phase loss and phase imbalance protection.
 - c. Visual indication of an overload trip condition shall be displayed on the VFD keypad.
 - d. Resetting an overload trip condition shall not require the opening of the enclosure door for safety reasons and shall be accomplished via a digital input, door mounted device (drive keypad), or over the serial communications.
5. A third contactor, the drive input contactor, shall be supplied. This shall allow powering of the VFD with the motor off or operating in bypass mode for testing, programming and troubleshooting purposes.
 6. Main input circuit breakers that protect the entire package shall be provided; also acts as the main disconnect.
 7. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFD input current rating, whichever is larger.
 8. Alarm contact that operates only when circuit breaker has tripped.

2.3 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.
 2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
 - a. Control Authority: Supports at least four conditions: Off, local manual control at VFD, local automatic control at VFD, and automatic control through a remote source.
- C. Historical Logging Information and Displays:
 1. Real-time clock with current time and date.
 2. Running log of total power versus time.

3. Total run time.
 4. Fault log, maintaining last four faults with time and date stamp for each.
- D. Indicating Devices: Digital display 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. DC-link voltage (V dc).
 9. Set point frequency (Hz).
 10. Motor output voltage (V ac).
- E. Control Signal Interfaces:
1. Electric Input Signal Interface:
 - a. A minimum of two programmable analog inputs.
 - b. A minimum of multifunction programmable digital inputs.
 2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC 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 two programmable analog output signals.
 4. Remote Indication Interface: A minimum of three 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 (overtemperature or overcurrent).
- F. Interface with DDC System for HVAC: Factory-installed hardware and software shall interface with DDC system for HVAC to monitor, control, display, and record data for use in processing reports. VFD settings shall be retained within VFD's nonvolatile memory.
1. Communication Interface: Comply with ASHRAE 135 BACnet Standard. Communication shall interface with DDC system for HVAC to remotely control and monitor motor operation from a DDC system for HVAC.

2.4 LINE CONDITIONING AND FILTERING

- A. Input Line Conditioning: Based on the manufacturer's harmonic analysis study and report, provide input filtering, as required, to limit total demand (harmonic current) distortion and total harmonic voltage demand at the defined point of common coupling to meet IEEE 519 recommendations.
 - 1. The harmonic analysis study shall include all new HVAC equipment and associated loads. As a minimum, all HVAC VFD's serving fans shall have a DC link reactor to provide full harmonic filtering throughout the entire load range. In performance, the DC-link reactor shall be equivalent to a 5% AC line reactor.

2.5 BYPASS SYSTEMS

- A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.
- B. Bypass Mode: Manual operation only; requires local operator selection at VFD. Transfer between power converter and bypass contactor, and retransfer shall only be allowed with the motor at zero speed.
- C. Bypass Controller: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter input and output and permit safe testing and troubleshooting of the power converter, both energized and de-energized, while motor is operating in bypass mode.
 - 1. Bypass Contactor: Load-break, NEC-rated contactor.
 - 2. Input and Output Isolating Contactors: Non-load-break, NEC-rated contactors.
 - 3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.
- D. Bypass Contactor Configuration: Full-voltage (across-the-line) type.
 - 1. DRIVE/OFF/BYPASS selector switch.
 - 2. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFD while the motor is running in the bypass mode.
 - 3. Contactor Coils: Pressure-encapsulated type with coil transient suppressors.
 - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
 - b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

- 4. 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) Tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

2.6 ADDITIONAL FEATURES

- A. Damper control circuit with end-of-travel feedback capability.
- B. Sleep Function: Senses a minimal deviation of a feedback signal and stops the motor. On an increase in speed-command signal deviation, VFD resumes normal operation.

2.7 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 3R. This includes VFDs mounted inside of outdoor air handling units.

2.8 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: Covered.
 - 2. Pilot Lights: Push to test.
 - 3. Selector Switches: Rotary type.
- B. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

2.9 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.
- B. VFDs will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, surfaces, and substrates to receive VFDs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.
- 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. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Wall-Mounting Controllers: Install 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 constructed with lightweight structural-steel channels.
- B. Comply with NECA 1.

3.3 CONTROL WIRING INSTALLATION

- A. Install wiring between VFDs and remote devices and facility's building automation system. Bundle, train, and support wiring in enclosures.
- B. 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.

3.4 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 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. 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.
- C. 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 Construction Manager before starting the motor(s).
 - 5. Test each motor for proper phase rotation.
 - 6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. VFDs will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies the VFD and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 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.

3.7 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 instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 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 8 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.
- E. Set field-adjustable circuit-breaker trip ranges.
- F. Set field-adjustable pressure switches.

3.8 PROTECTION

- A. Replace VFDs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.9 DEMONSTRATION

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

END OF SECTION 230512

SECTION 230513 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Dielectric fittings.
 - 3. Sleeves.
 - 4. Escutcheons.
 - 5. Floor Plates.
 - 6. Concrete for housekeeping pads.
 - 7. Electric heat trace for outdoor piping.

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, pipe and duct shafts, unheated spaces immediately below roof, and spaces above ceilings.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 and 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

- A. Refer to individual Division 22 and 23 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

2.3 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.4 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

2.5 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.
- C. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

- D. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.

2.6 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.7 CONCRETE MIXTURES

- A. Comply with ACI 301 requirements for concrete mixtures.
- B. Normal-Weight Concrete: Prepare design mixes, proportioned according to ACI 301, as follows:
 - 1. Minimum Compressive Strength: 4000 psi at 28 days.
 - 2. Maximum Water-Cementitious Materials Ratio: 0.50.
 - 3. Slump Limit: 4 inches, plus or minus 1 inch.
 - 4. Air Content: Maintain within range permitted by ACI 301. Do not allow air content of floor slabs to receive troweled finishes to exceed 3 percent.
- C. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
 - 1. Fly Ash: 25 percent.
 - 2. Ground Granulated Blast-Furnace Slag: 25 percent.

2.8 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, & deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
- B. When air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

2.9 ELECTRIC HEAT TRACE FOR OUTDOOR PIPING

- A. General: Provide a complete UL Listed and FM Approved system of heating cables, components, and controls in outdoor locations to prevent hydronic piping from freezing.
- B. The heating cable shall be SRF cable as manufactured by Chromalox or equal.
- C. The heating cable for metal-pipe freeze protection shall be sized based on 0°F minimum ambient temperature.
- D. The self-regulating cable shall consist of two (2) 16 AWG nickel-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature all along its length, allowing the heating cable to be cut to

length in the field. A modified polyolefin dielectric jacket shall cover the heating cable. To provide a ground path and to enhance the heating cable's ruggedness, the heating cable shall have a braid of tinned copper (-C), as required per the NEC.

- E. In order to provide rapid heat-up, and to prevent overheating of fluids and plastic pipe, the heating cable shall have a minimum self-regulating index of $-0.058 \text{ W/}^\circ\text{F}$ for heating cable capacity of 8 W/ft.
- F. In order to facilitate longer circuit lengths and smaller breaker sizing, the heating cable shall have the following maximum inrush current at 50°F : 210 mA/ft maximum inrush @ time = 1 sec and 180 mA/ft maximum inrush @ time = 10 sec for heating cable capacity of 8 W/ft, 120 volt.
- G. The heating cable shall operate on line voltage of 120 volts without the use of transformers.
- H. Power connection, end seal, splice, and tee kit components shall be applied in the field.
- I. A ground-fault device for equipment protection shall protect heating cable circuit. This requirement is in accordance with the NEC.
- J. Component enclosures shall be rated NEMA 4X to prevent water ingress and corrosion. In order to ensure the most reliable electrical connection and to simplify the maintenance and troubleshooting of freeze protection systems only terminal block connections are acceptable.
- K. Thermostatic Control - Line Sensing: The system shall be controlled by a line sensing thermostat set at $0\text{-}40^\circ\text{F}$ (adjustable). Contactor enclosure type NEMA 4 shall be used.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems. All piping that is installed with corroded or rusted exterior surfaces shall be completely cleaned and primed with rust proof paint before exterior pipe insulation is applied and installed.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors.
- M. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
 - 1. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - 2. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - 3. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
 - 4. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
- N. Install floor plates for piping penetrations of equipment-room floors.
- O. Install sleeves for all pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- Q. The HVAC Contractor shall provide the complete installation for electric heat trace of outdoor piping including the final power supply connection. Refer to Section 230511.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 CONCRETE HOUSEKEEPING PADS

- A. Provide extension of concrete housekeeping pads for indoor HVAC equipment.
- B. Design, construct, erect, brace, & maintain formwork according to ACI 301.
- C. Comply with ACI 301 for measuring, batching, mixing, transporting, & placing concrete.
- D. Dowel new concrete with anchors embedded into existing concrete slab.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

- C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

END OF SECTION 230513

SECTION 230515 - ROOFTOP FALL PROTECTION GUARDRAILS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Free-standing rooftop fall protection guardrail systems.
- B. Safety railing kits.

1.2 REFERENCES

- A. American National Standards Institute (ANSI):
 - 1. A 21.1 - Safety Requirements for Floor and Wall Openings, Railings and Toe Boards.
 - 2. A 58.1 - Minimum Design Loads in Buildings and Other Structures.
 - 3. A 117.1 - Accessible and Usable Buildings and Facilities.
- B. ASTM International (ASTM):
 - 1. ASTM A 47 - Standard Specification for Ferritic Malleable Iron Castings.
 - 2. ASTM A 53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 3. ASTM A 153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- C. Occupational Safety and Health Administration (OSHA):
 - 1. 1910.29 – Fall Protection Systems and Falling Object Protection
 - 2. 1910.501 and 1910.502 - Fall Protection Systems Criteria and Practices

1.3 QUALITY ASSURANCE

- A. Railings Structural Requirements:
 - 1. Handrail, wall rail and guardrail assemblies and attachments shall withstand a minimum concentrated load of 200 pounds applied horizontally or vertically down at any point on the top rail.
 - 2. Handrail assemblies and guards shall be designed to resist a load of 50 pounds per linear foot applied in any direction at the top and to transfer this load through the supports to the structure.
 - 3. Infill area of guardrail system capable of withstanding a horizontal concentrated load of 200 pounds applied to one square foot at any point in the system. Load not to act concurrently with loads on top rail of system in determining stress on guardrail.

1.4 COORDINATION

- A. Coordinate fall protection guardrail systems with dimensions of new roof mounted

HVAC units. Field verify required section lengths and layout dimensions to provide free standing guardrail system along entire roof edge within 15 feet of each roof mounted HVAC unit.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store and handle materials and products in strict compliance with manufacturer's instructions and recommendations and industry standards.
- B. Protect finishes from damage.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by Kee Safety, Inc. / Fall Protection Systems (800-851-5181), Garlock Safety Systems (877-791-4446) or Engineer approved equal.

2.2 FREE-STANDING ROOFTOP FALL PROTECTION SYSTEMS (KEEGUARD)

- A. Free-Standing Rooftop Fall Protection Systems:
 - 1. Description: Permanent, modular, free-standing, roof edge railing system that does not penetrate the roofing system.
 - 2. Provide components including but not limited to pipe railings, uprights, bases, counterweights, fittings and accessories as required for complete installation.
 - 3. Compliance:
 - a. OSHA Standards including referenced documents in Part 1.
 - b. 42 inch minimum height to provide a pedestrian egress barrier on the roof to withstand a minimum load of 200 lb.
 - 4. System Design: Designed for applications with flat or low slope roof up to 3 degrees.
 - a. Counterbalances: With one fixing collar per counterbalance.
 - 5. Pipes: Galvanized steel, 12 gauge, ASTM A 53 Grade B seamed tube.
 - 6. Fittings: Galvanized malleable cast iron, ASTM A 47 with ASTM A 153 galvanizing.
 - 7. Fasteners: Type 304 or 305 stainless steel.
 - 8. Components:
 - a. Galvanized steel guardrails, 1-5/8 inch diameter tube or as required for performance criteria.
 - b. Counterweight Levers: Galvanized tube, 12 gauge, 1-1/4 inch nominal size.
 - c. Mounting Bases: Galvanized steel with rubber pad on underside.

2.3 FABRICATION

- A. Fit and shop assemble components in largest practical sizes for delivery to site.

- B. Upright tops shall be plugged with galvanized steel or weather and light resistant material.
- C. Assemble components with joints tightly fitted and secured. Accurately form components to suit installation.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Prepare substrates using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions including the following:
 - 1. Fit exposed connections accurately together to form tight joints. Tighten set screws in accordance with manufacturer's requirements.
 - 2. Perform cutting, drilling, and fitting required for installation of handrails. Set handrails and accurately in location, alignment, and elevation, measured from established lines and levels.
 - 3. Set posts plumb within a tolerance of 1/8 inch.

3.3 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 230515

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SECTION 230523 - VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following general-duty valves:

1. Copper-alloy ball valves.
2. High performance butterfly valves.
3. Bronze check valves.
4. Strainers

1.2 SUBMITTALS

- A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; furnished specialties; and accessories.

1.3 QUALITY ASSURANCE

- A. ASME Compliance: ASME B31.9 for building services piping valves.
- B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.
- C. All domestic water valves shall be lead free.
- D. Comply with NSF 61, "Drinking Water System Components-Health Effects" and NSF 372.
- E. Comply with Federal "Safe Drinking Water Act" and "Reduction of Lead in Drinking Water Act".

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 VALVES, GENERAL

- A. Refer to Part 3 "Valve Applications" Article for applications of valves.
- B. Bronze Valves: NPS 2 and Smaller: Threaded ends, unless otherwise indicated.
- C. Ferrous Valves NPS 2-1/2 and Larger: Flanged ends, unless otherwise indicated.
- D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
- F. Valve Actuators:
 - 1. OS&Y with Handwheel: Site water and service entrance water valves.
 - 2. Handwheel: For valves other than quarter-turn types.
 - 3. Lever Handle: For quarter-turn valves NPS 4 and smaller.
- G. Extended Valve Stems: On insulated valves.
- H. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.
- I. Valve Grooved Ends: AWWA C606.
- J. Valve Bypass and Drain Connections: MSS SP-45.

2.3 COPPER-ALLOY BALL VALVES

- A. Manufacturers:
 - 1. Copper-Alloy Ball Valves:
 - a. Conbraco Industries, Inc.; Apollo Div.
 - b. Milwaukee Valve Company
 - c. Nibco
 - d. Watts
- B. Copper-Alloy Ball Valves, General: MSS SP-110.
- C. Copper-Alloy Ball Valves: Bronze body with full-port, chrome-plated bronze ball; reinforced TFE seats; blowout-proof stem; 600-psig minimum CWP rating up to NPS 3; 400-psig minimum CWP rating for NPS 4.

2.4 HIGH PERFORMANCE BUTTERFLY VALVES

- A. Manufacturers:
 - 1. Single-Flange, Ferrous-Alloy Butterfly Valves:
 - a. Victaulic Co. - MasterSeal
 - b. Crane Co.; Crane Valve Group; Stockham Div.
 - c. Milwaukee Valve Company

- d. Mueller Co.
- e. Nibco
- f. Watts

- B. Ferrous-Alloy Butterfly Valves, General: Pressure rated from full vacuum to 200 psi and for bi-directional, dead end service to full working pressure; seat design that assures full 360° sealing; ductile iron disc conforming to ASTM A-536, grade 65-45-12, with electroless nickel coating conforming to ASTM B-733; 416 stainless steel blowout proof stem conforming to ASTM A-582; EPDM seat with temperature range –30°F to +250°F; lever lock handle or gear operator handwheel with chainwheel as applicable.

2.5 BRONZE CHECK VALVES

- A. Manufacturers:
- 1. Bronze, Swing Check Valves with Nonmetallic Disc:
 - a. Crane Co.; Crane Valve Group; Stockham Div.
 - b. Milwaukee Valve Company.
 - c. Nibco
- B. Bronze Check Valves, General: MSS SP-80.
- C. Class 150, Bronze, Horizontal Lift Check Valves: Bronze body with nonmetallic disc and bronze seat.
- D. Class 150, Bronze, Swing Check Valves: Bronze body with nonmetallic disc and bronze seat.

2.6 STRAINERS

- A. Wye-Pattern Strainers, NPS 2 and Smaller: wye-pattern, cast steel or cast copper silicon alloy body with threaded connections, stainless steel screen, solid retainer cap and blow-down plug. 400-psig minimum pressure rating at 210°F.
- B. Wye-Pattern Strainers, NPS 2-1/2 and Larger: wye-pattern, ductile iron body with flanged connections, stainless steel screen, bolted and tapped iron retainer cap with graphite gasket, and iron blow-down plug. 500-psig minimum pressure rating at 150°F.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

- A. Use the following:
- 1. Shutoff or Throttling Service:
 - a. NPS 2 (DN 50) and Smaller: Ball valves.
 - b. NPS 2-1/2 (DN 65) and Larger: Ball valves or high performance butterfly valves.

2. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

3.2 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.3 VALVE INSTALLATION

- A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves in horizontal piping with stem at or above center of pipe.
- E. Install valves in position to allow full stem movement.
- F. Install valves at all branch take off.
- G. Install check valves for proper direction of flow and as follows:
 1. Swing Check Valves: In horizontal position with hinge pin level.
 2. Lift Check Valves: With stem upright and plumb.

3.4 JOINT CONSTRUCTION

- A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.
- B. Flanged Joints: Assemble joints with gasket and bolts according to coupling and fitting manufacturer's written instructions.

- C. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
- D. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 230523

SECTION 230529 - HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes hangers and supports for mechanical system piping and equipment.

1.2 PERFORMANCE REQUIREMENTS

- A. Design channel support systems for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

1.3 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 MANUFACTURED UNITS

- A. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components.
 - 1. Manufacturers:
 - a. B-Line Systems, Inc.
 - b. Carpenter & Patterson, Inc.
 - c. Globe Pipe Hanger Products, Inc.
 - d. Grinnell Corp.
 - e. GS Metals Corp.
 - f. National Pipe Hanger Corp.
 - 2. Galvanized, Metallic Coatings: For piping and equipment that will not have field-applied finish.
 - 3. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
 - 4. Field Painted Coatings: For all pipe hangers that are not coated shall have field-applied finish applied. Finish shall be one coat of primer and two coats of approved paint.

- B. Channel Support Systems: MFMA-2, factory-fabricated components for field assembly.
 - 1. Manufacturers:
 - a. B-Line Systems, Inc.
 - b. Grinnell Corp.
 - c. GS Metals Corp.
 - d. Thomas & Betts Corp.
 - e. Unistrut Corp.
 - 2. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
 - 3. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- C. Thermal-Hanger Shield Inserts: 100-psi minimum compressive-strength insulation, encased in sheet metal shield.
 - 1. Manufacturers:
 - a. Carpenter & Patterson, Inc.
 - b. PHS Industries, Inc.
 - c. Pipe Shields, Inc.
 - d. Rilco Manufacturing Co., Inc.
 - e. Value Engineered Products, Inc.
 - 2. Material for Cold Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate with vapor barrier.
 - 3. Material for Hot Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate.
 - 4. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
 - 5. For Clevis or Band Hanger: Insert and shield cover lower 180 degrees of pipe.
 - 6. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.3 MISCELLANEOUS MATERIALS

- A. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- C. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Specific hanger requirements are specified in Sections specifying equipment and systems.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification Sections.
- C. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
 - 1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
- D. Building Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
 - 1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 - 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
 - 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 - 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 - 5. C-Clamps (MSS Type 23): For structural shapes.
- E. Shields: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
 - 1. Protection Shields (MSS Type 40): Of length recommended by manufacturer to prevent crushing insulation.

3.2 INSTALLATION

- A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems. Field assemble and install according to manufacturer's written instructions.
- C. 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. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- D. Install powder-actuated drive-pin fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool

manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

- E. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- F. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- G. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- H. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," is not exceeded.
- I. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.9.
 - 2. Install MSS SP-58, Type 40 protective shields on cold piping. Shields shall span arc of 180 degrees.
 - 3. Shield Dimensions for Pipe: Not less than 12 inches long and 0.048 inch thick.

3.3 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.4 PAINTING

- A. Touching Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces. Apply paint by brush to provide a minimum dry film thickness of 2.0 mils. One coat of primer and two coats of finish, approved paint.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 230529

SECTION 230553 - MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following mechanical identification materials and their installation for plumbing and HVAC systems:
 - 1. Equipment nameplates.
 - 2. Pipe markers.
 - 3. Valve tags.

1.2 SUBMITTALS

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

1.3 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

- A. Equipment Nameplates: Plastic with data engraved for permanent attachment on equipment.
 - 1. Format and Data:
 - a. Data shall include (but not limited to) equipment tag, manufacturer, model number, serial number, room served, date in service, warranty end date, and electrical circuit (panel and breaker number).
 - b. Capacity, operating and power characteristics, and essential data, unless already shown on the manufacturer's factory equipment label.
 - c. Labels of tested compliances.
 - 2. Location: Accessible and visible.
 - 3. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive as required to mount on equipment.
 - 4. Nameplate Size: 4-1/2 by 6 inches.
 - 5. Letter Size: 1/2 inch.
 - 6. Color: White letters on a red background.

2.2 PIPING IDENTIFICATION DEVICES

- A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
 - 1. Colors: Comply with ASME A13.1, unless otherwise indicated.
 - 2. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
 - 3. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
 - 4. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

2.3 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme. Provide 5/32-inch hole for fastener.
 - 1. Material: 0.032-inch- thick brass, 2 inches round.
 - 2. Valve-Tag Fasteners: 10 gauge brass S-hook.

2.4 CEILING LABELS

- A. Clear self-adhesive label, 3/4-inch wide with 3/8-inch high black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of incompatible primers as well as dirt, oil, grease, release agents, and other substances that could impair bond of paint and identification devices.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be installed.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT IDENTIFICATION

- A. Install and permanently fasten equipment nameplates on each HVAC and plumbing unit. This shall include all HVAC and Plumbing equipment including pumps, air terminal units, cabinet and unit heaters, convectors, and split systems.
- B. Equipment tags shall have a 2-part designation:

1. Part 1 – Unit Symbol (e.g. “DOAS” for Dedicated Outdoor Air Handling System Unit).
 2. Part 2 – Unit Number
- C. Install and permanently fasten equipment nameplates on wall adjacent each fire damper.

3.4 PIPING IDENTIFICATION

- A. Painting: Paint piping or piping insulation for all Boiler Room and Mechanical Room piping with two (2) coats. Refer to Division 09 Section for painting of piping. Color code requirements:
 - 1. Hot Water Heating – Red
 - 2. Chilled Water – Light Blue
 - 3. 2-Pipe Heating / Chilled Water - Green
 - 4. Domestic Cold Water – Blue
 - 5. Domestic Hot Water – Orange
 - 6. Natural Gas – Yellow
 - 7. #2 Fuel Oil – Black
- B. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow. Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.
- C. Locate pipe markers and color bands as follows:
 - 1. Near equipment connections.
 - 2. Spaced at maximum intervals of 20 feet along each run.

3.5 CEILING GRID IDENTIFICATION

- A. Install clear self-adhesive label, 3/4-inch wide with 3/8-inch high black lettering, to identify location of all concealed HVAC and plumbing equipment and valves located above ceilings. Mount labels on ceiling grid or frame of access door.

3.6 ADJUSTING AND CLEANING

- A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes testing, adjusting, and balancing HVAC systems to produce design objectives, including the following:
 - 1. Balancing airflow and water flow within distribution systems, including submains, branches, and terminals, to indicated quantities according to specified tolerances.
 - 2. Adjusting total HVAC systems to provide indicated quantities.
 - 3. Measuring electrical performance of HVAC equipment.
 - 4. Setting quantitative performance of HVAC equipment.
 - 5. Verifying that automatic control devices are functioning properly.
 - 6. Measuring sound and vibration.
 - 7. Reporting results of activities and procedures specified in this Section.

1.2 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. AMCA: Air Movement and Control Association.
- C. NEBB: National Environmental Balancing Bureau.
- D. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.
- E. TAB: Testing, adjusting, and balancing.

1.3 SUBMITTALS

- A. Strategies and Procedures Plan: Testing, adjusting, and balancing strategies and step-by-step procedures. Include a complete set of report forms intended for use on this Project. These documents shall be submitted 60 days before any onsite TAB work is scheduled to start.
- B. Certified Testing, Adjusting, and Balancing Reports: Prepared on approved forms certified by the testing, adjusting, and balancing Agent.

1.4 QUALITY ASSURANCE

- A. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by AABC or NEBB.

- B. Certification of Testing, Adjusting, and Balancing Reports: Certify testing, adjusting, and balancing field data reports. This certification includes the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.
 - 2. Certify that testing, adjusting, and balancing team complied with approved testing, adjusting, and balancing plan and procedures specified and referenced in this Specification.
- C. Testing, Adjusting, and Balancing Reports: Use standard forms from AABC's "National Standards for Testing, Adjusting, and Balancing" or NEBB equivalent.
- D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."
- E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- F. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.5 PROJECT CONDITIONS

- A. Owner Occupancy: Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner's operations. Coordinate all work with the Construction Manager.

1.6 COORDINATION

- A. Coordinate efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.
- B. Perform testing, adjusting, and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.7 WARRANTY

- A. National Project Performance Guarantee: Provide a guarantee on AABC'S "National Standards" forms or NEBB equivalent stating that AABC or NEBB will assist in completing the requirements of the Contract Documents if the testing, adjusting, and balancing Agent fails to comply with the Contract Documents. Guarantee includes the following provisions:
 - 1. The certified Agent has tested and balanced systems according to the Contract Documents.
 - 2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with project requirements and to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.
 - 1. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- B. Examine approved submittal data of HVAC systems and equipment.
- C. Examine Project Record Documents.
- D. Examine equipment performance data, including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- E. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.
- F. Examine system and equipment test reports.
- G. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- H. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

- I. Examine air-handling equipment to ensure clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, such as variable-air-volume boxes and mixing boxes, to verify that they are accessible and their controls are connected and functioning.
- K. Examine strainers for clean screens and proper perforations.
- L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- M. Examine system pumps to ensure absence of entrained air in the suction piping.
- N. Examine equipment for installation and for properly operating safety interlocks and controls.
- O. Examine automatic temperature system components to verify the following:
 - 1. Dampers, valves, and other controlled devices operate by the intended controller.
 - 2. Dampers and valves are in the position indicated by the controller.
 - 3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in mixing boxes and variable-air-volume terminals.
 - 4. Automatic modulating and shutoff valves, including two-way valves, are properly connected.
 - 5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 - 6. Sensors are located to sense only intended conditions.
 - 7. Sequence of operation for control modes is according to the Contract Documents.
 - 8. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.
 - 9. Interlocked systems are operating.
- P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.
- B. Complete system readiness checks and prepare system readiness reports. Verify the following:
 - 1. Permanent electrical power wiring is complete.

2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so design conditions for system operations can be met.

3.3 TESTING AND BALANCING PROCEDURES

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
 1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.
- C. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, and similar controls and devices, to show final settings.

3.4 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances:
 1. Supply Fans: 0 to plus 5 percent.
 2. Exhaust Fans: Minus 5 to plus 5 percent.
 3. Air Outlets and Inlets: Minus 5 to plus 5 percent.
 4. Heating and Chilled Water Flow Rate: Minus 5 to plus 5 percent.

3.5 REPORTS

- A. Status Reports: As Work progresses, prepare 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.

- B. Final Report: Typewritten, or computer printout in letter-quality font, on standard bond paper, bound in three-ring, loose-leaf binder, and tabulated and divided into sections by tested and balanced systems.
1. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing agent.
 2. Include a list of instruments used for procedures, along with proof of calibration.
 3. Final Report Contents: In addition to certified field report data, include the following:
 - a. Pump curves.
 - b. Fan curves.
 - c. Manufacturers' test data.
 - d. Field quality-control test reports prepared by system and equipment installers.
 - e. Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data.
 4. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
 - a. Title page.
 - b. Name and address of testing, adjusting, and balancing Agent.
 - c. Project name.
 - d. Project location.
 - e. Construction Manager's name and address.
 - f. Architect's name and address.
 - g. Engineer's name and address.
 - h. Contractor's name and address.
 - i. Report date.
 - j. Signature of testing, adjusting, and balancing Agent who certifies the report.
 - k. Summary of contents, including the following:
 - 1) Design versus final performance.
 - 2) Notable characteristics of systems.
 - 3) Description of system operation sequence if it varies from the Contract Documents.
 - l. Nomenclature sheets for each item of equipment.
 - m. Data for terminal units, including manufacturer, type size, and fittings.
 - n. Notes to explain why certain final data in the body of reports vary from design values.
 - o. Test conditions for fans and pump performance forms, including the following:
 - 1) Settings for outside-, return-, and exhaust-air dampers.
 - 2) Conditions of filters.
 - 3) Cooling coil, wet- and dry-bulb conditions.
 - 4) Fan drive settings.
 - 5) Variable Frequency Drive settings for variable-air-volume and variable-flow air and water systems.
 - 6) Settings for supply-air, static-pressure controller.
 - 7) Other system operating conditions that affect performance.

5. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present with single-line diagrams and include the following:
 - a. Quantities of outside, supply, return, and exhaust airflows.
 - b. Water flow rates.
 - c. Duct, outlet, and inlet sizes.
 - d. Pipe and valve sizes and locations.
 - e. Terminal units.
 - f. Balancing stations.

END OF SECTION 230593

SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes duct insulation, insulating cements, field-applied jackets, and accessories and attachments.

1.2 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Provide products with flame-spread and smoke-developed indices of 25 and 50, respectively, according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Mineral-Fiber Insulation:
 - a. Johns Manville
 - b. Knauf FiberGlass GmbH.
 - c. Owens-Corning Fiberglas Corp.
 - 2. Grease Duct Insulation: 3M
 - 3. Outdoor Membrane Field-Applied Jackets:
 - a. Carlisle Corp.
 - b. Firestone Building Products

2.2 INSULATION MATERIALS

- A. Mineral-Fiber Board Thermal Insulation: Glass fibers bonded with a thermosetting resin; Comply with ASTM C 612, Type IB. White Kraft finish suitable for painting, with beach puncture resistance of 50 units minimum. Vapor barrier shall be adhered to inner surface of jacket. Permeance shall not exceed 0.02 perm. Owens-Corning "ASJ" or Johns Manville "AP".
- B. Mineral-Fiber Blanket Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II, ASTM C 1338 (No mold growth) and GREENGUARD Certification; formaldehyde free; all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.

- C. Outdoor Membrane Field-Applied Jackets: Single-ply EPDM membrane; white color; minimum 60 mil thickness; compatible sealant from same manufacturer to ensure a weatherproof system.
- D. Accessories and Attachments:
 - 1. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, pre-sized minimum 8 oz./sq. yd.
 - 2. Bands: Aluminum 3/4 inch wide.
 - 3. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft-annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.
 - 4. Weld-Attached Anchor Pins and Washers: Copper-coated steel pin for capacitor-discharge welding and galvanized speed washer. Pin length sufficient for insulation thickness indicated.
 - 5. Adhesive-Attached Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.

PART 3 - EXECUTION

3.1 GENERAL APPLICATION REQUIREMENTS

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application. Clean and primer all areas with corrosion before applying insulation.
- B. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; and free of voids throughout the length of ducts and fittings.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- E. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- F. Apply insulation with the least number of joints practical.
- G. Apply insulation over fittings and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
- H. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic. Apply insulation continuously through hangers and around anchor attachments.

- I. Insulation Terminations: For insulation application where vapor retarders are indicated, seal ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- J. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions.
- K. Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire/smoke damper sleeves for fire-rated wall and partition penetrations.

3.2 DUCT AND PLENUM APPLICATION SCHEDULE

- A. Service: Rectangular and round, supply-air and return-air ducts including DOAS return-air/exhaust-air ducts, concealed.
 - 1. Material: Mineral-fiber blanket.
 - 2. Thickness: 1-1/2 inches.
 - 3. Density: 1.0 lb/ft³
 - 4. Number of Layers: One.
 - 5. Factory-Applied All Service Jacket: Foil and paper.
 - 6. Vapor Retarder Required: Yes.
- B. Service: Rectangular, supply-air, return-air including DOAS return-air/exhaust-air ducts, and outside-air ducts, exposed indoors (including Locker Rooms, Storage Rooms and Stage / Part-Time Classroom)
 - 1. Material: Mineral-fiber board.
 - 2. Thickness: 1-1/2 inches.
 - 3. Density: 3.0 lb/ft³
 - 4. Number of Layers: One.
 - 5. Factory-Applied All Service Jacket: White finish
 - 6. Vapor Retarder Required: Yes.
- C. Service: Rectangular, supply-air ducts, return-air ducts, and exhaust-air ducts exposed outdoors for Drexel Hill Middle School
 - 1. Material: Mineral-fiber board.
 - 2. Thickness: 3 inches.
 - 3. Density: 6.0 lb/ft³
 - 4. Number of Layers: Two.
 - 5. Additional Layer: Located on top of duct and taper in two directions from centerline of duct to shed water (minimum 2% slope).
 - 6. Field-Applied Jacket: Outdoor weatherproof membrane system with white finish.
 - 7. Vapor Retarder Required: Yes.

END OF SECTION 230713

SECTION 230719 - PIPE INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes semirigid and flexible piping insulation, insulating cements, field-applied jackets, accessories and attachments, and sealing compounds.

1.2 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Provide products with flame-spread and smoke-developed indices of 25 and 50, respectively, according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Mineral-Fiber Insulation:
 - a. Johns Manville.
 - b. Knauf FiberGlass GmbH.
 - c. Owens-Corning Fiberglas Corp.
 - 2. Flexible Elastomeric Thermal Insulation:
 - a. Armstrong World Industries, Inc.
 - b. Rubatex Corp.

2.2 PIPE INSULATION MATERIALS

- A. Mineral-Fiber Insulation: Glass fibers bonded with a thermosetting resin complying with the following:
 - 1. Preformed Pipe Insulation: Comply with ASTM C 547, Type 1, with factory-applied, all-purpose, vapor-retarder jacket.
 - 2. Blanket Insulation: Comply with ASTM C 553, Type II, without facing.
 - 3. Fire-Resistant Adhesive: Comply with MIL-A-3316C Class 1, Grade A for bonding glass cloth and tape to unfaced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to unfaced glass-fiber insulation.
 - 4. Vapor-Retarder Mastics: Fire- and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.
 - 5. Mineral-Fiber Insulating Cements: Comply with ASTM C 195.

6. Expanded or Exfoliated Vermiculite Insulating Cements: Comply with ASTM C 196.
7. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

B. Field-Applied Jackets: ASTM C 921, Type 1, unless otherwise indicated.

1. Foil and Paper Jacket: Laminated, glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil.
2. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils thick; roll stock ready for shop or field cutting and forming.
3. Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil- thick, high-impact, ultraviolet-resistant PVC.

C. Accessories and Attachments:

1. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz./sq. yd..
2. Bands: 3/4 inch wide aluminum.
3. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft-annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.

2.3 EQUIPMENT INSULATION MATERIALS

- A. Flexible Elastomeric Thermal Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials. Adhesive as recommended by manufacturer.

PART 3 - EXECUTION

3.1 GENERAL APPLICATION REQUIREMENTS

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; and free of voids throughout the length of ducts and fittings.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- E. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.

- F. Apply insulation with the least number of joints practical.
- G. Apply insulation over fittings and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
- H. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic. Apply insulation continuously through hangers and around anchor attachments.
- I. Insulation Terminations: For insulation application where vapor retarders are indicated, seal ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- J. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.
- K. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions.
- L. Floor Penetrations: Terminate insulation at underside of floor assembly and at floor support at top of floor.

3.2 PIPE INSULATION APPLICATION SCHEDULE

- A. Service: Domestic cold water and condensate piping.
 - 1. Operating Temperature: 35 to 60 deg F.
 - 2. Insulation Material: Mineral fiber.
 - 3. Insulation Thickness: 1 inch
 - 4. Jacket: Foil and paper, white finish all service jacket.
 - 5. Vapor Retarder Required: Yes.
- B. Service: Domestic hot and recirculated hot water.
 - 1. Operating Temperature: 60 to 140 deg F.
 - 2. Insulation Material: Mineral fiber.
 - 3. Insulation Thickness: 1 inch
 - 4. Jacket: Foil and paper, white finish all service jacket.
- C. Service: Rainwater conductors and roof drain bodies.
 - 1. Operating Temperature: 32 to 100 deg F.
 - 2. Insulation Material: Mineral fiber.
 - 3. Insulation Thickness: 1 inch
 - 4. Jacket: Foil and paper, white finish all service jacket.
 - 5. Vapor Retarder Required: No.
- D. Service: Heating hot water supply and return.
 - 1. Operating Temperature: 100 to 200 deg F.
 - 2. Insulation Material: Mineral fiber.

3. Insulation Thickness:
 - a. 2 inches for pipes 1 ½ inches and larger.
 - b. 1 ½ inches for pipes smaller than 1 ½ inches.
 - c. 2 inches for piping outdoors or located inside rooftop air handling units.
 4. Jacket: Foil and paper, white finish all service jacket indoors; PVC jacket outdoors.
 5. Vapor Retarder Required: No.
- E. Service: Refrigerant suction (gas), and refrigerant liquid piping.
1. Operating Temperature: 35 to 120 deg F.
 2. Insulation Material: Flexible Elastomeric.
 3. Insulation Thickness: 1 inch.
 4. Field-Applied Jacket: PVC for outdoor applications.

END OF SECTION 230719

SECTION 230900 - HVAC CONTROLS AND INSTRUMENTATION

PART 1 - GENERAL

1.1 RELATED SECTIONS

- A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are part of this specification and shall be used in conjunction with this section as part of the contract documents.
- B. All Division 23 sections.
- C. The following Division 26 sections constitute related work:
 - 1. Section 260519 – Low Voltage Electrical Power Conductors and Cables
 - 2. Section 260523 – Control Voltage Electrical Power Conductors and Cables
 - 3. Section 260526 – Grounding and Bonding for Electrical Systems
 - 4. Section 262726 – Wiring Devices

1.2 DESCRIPTION

- A. General: The control system shall consist of a high-speed, peer-to-peer network of DDC controllers, a control system server, and a web-based operator interface.
- B. System software shall be based on a server/thin client architecture, designed around the open standards of web technology. The control system server shall be accessed using a Web browser over the control system network, the owner's local area network, and over the Internet. The intent of the thin-client architecture is to provide operators complete access to the control system via a Web browser. No special software other than a web browser shall be required to access graphics, point displays, and trends, configure trends, configure points and controllers, or to download programming into the controllers.
- C. System shall use the BACnet protocol according to ANSI/ASHRAE Standard 135 for communication to the operator workstation or web server and for communication between control modules. The system shall be an open architecture with the capabilities to support a multi-vendor environment. To accomplish this effectively, the control system shall support open communication protocol standards and integrate a wide variety of third-party devices and applications. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other owner provided networks. The system shall not be limited to only use open communication protocols, but also be able to integrate a wide variety of third-party devices and applications via existing vendor protocols and through the latest software standards.
- D. Subject to compliance with requirements, system architecture that utilizes a Tridium certified Niagara Framework is acceptable.

- E. The system shall be modular in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.
- F. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

1.3 QUALITY ASSURANCE

A. General

- 1. The control system shall be completely installed and place in operating condition by a firm specializing in this type of work. The firm shall provide a single source responsibility for all system components, engineering services, maintenance and warranty.
- 2. The Controls Contractor shall be qualified and thoroughly experienced in providing single source responsibility for the Automatic Temperature Control System.
- 3. The Controls Contractor shall be fully responsible for the complete design, installation and proper operation of the system, including but not limited to: Data and control signal transmission systems, direct digital controllers and interfacing of all system equipment, sensors and controls, memory units and peripheral devices.
- 4. After the installation, the Controls Contractor shall be responsible for the debugging and calibration of the system, including all software, and maintenance of the system until the system functions in accordance with these specifications and successfully completes the final operational acceptance test. The Controls Contractor's responsibilities shall also include all software and software maintenance during the warranty period.

1.4 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 the current editions in effect 30 days prior to the receipt of bids of the following codes:
 - 1. National Electric Code (NEC)
 - 2. International Building Code (IBC)
 - a. Section 719 Ducts and Air Transfer Openings
 - b. Section 907 Fire Alarm and Detection Systems
 - c. Chapter 28 Mechanical
 - 3. International Mechanical Code (IMC)
 - 4. ANSI/ASHRAE Standard 135, BACnet - A Data Communication Protocol for Building Automation and Control Systems

1.5 SYSTEM PERFORMANCE

- A. Performance Standards. System shall conform to the following minimum standards over network connections. Systems shall be tested using manufacturer's recommended hardware and software for operator workstation (server and browser for web-based systems).
1. Graphic Display. A graphic with 20 dynamic points shall display with current data within 10 sec.
 2. Graphic Refresh. A graphic with 20 dynamic points shall update with current data within 8 sec. and shall automatically refresh every 15 sec.
 3. Configuration and Tuning Screens. Screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic shall automatically refresh within 6 sec.
 4. Object Command. Devices shall react to command of a binary object within 2 sec. Devices shall begin reacting to command of an analog object within 2 sec.
 5. Alarm Response Time. An object that goes into alarm shall be annunciated at the workstation within 45 sec.
 6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 sec. Select execution times consistent with the mechanical process under control.
 7. 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.
 8. Multiple Alarm Annunciation. Each workstation on the network shall receive alarms within 5 sec of other workstations.
 9. Reporting Accuracy. System shall report values with minimum end-to-end accuracy listed in Table 1.
 10. 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°F
Ducted Air	±0.5°F
Outside Air	±1°F
Dew Point	±2°F
Water Temperature	±0.5°F
Delta-T	±0.25°F
Relative Humidity	±2% RH from 20% to 80% RH
Water Flow	±2% of full scale
Airflow (terminal)	±3% of full scale (see Note 1)
Air Pressure (ducts)	±0.03 in. w.g.
Air Pressure (space)	±0.005 in. w.g.
Water Pressure	±2% of full scale (see Note 2)
Electrical	±1% of reading (see Note 3)

Carbon Monoxide	±3% of reading
Carbon Dioxide (CO2)	±30 ppm (see Note 1)

Note 1: Accuracy applies to 10%–100% of scale

Note 2: For both absolute and differential pressure

Note 3: Not including utility-supplied meters

Table 2
 Control Stability and Accuracy

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	±0.1 in. w.g. ±0.005 in. w.g.	0–4 in. w.g. -0.1 to 0.1 in. w.g.
Airflow	±5% of full scale	
Space Temperature	±1.0°F	
Duct Temperature	±2°F	
Humidity	±3% RH	
Fluid Pressure	±1.0 psi ±0.5 in. w.g.	1–150 psi 0–25 in. w.g. differential

1.6 SUBMITTALS

- A. **Product Data and Shop Drawings:** Meet requirements of Division 1 for Shop Drawings. In addition, the Controls Contractor shall provide shop drawings or other submittals on hardware, software, and equipment to be installed or provided. No work may begin on any segment of this project until submittals have been approved for conformity with design intent. Provide drawings as AutoCAD compatible files on magnetic or optical disk (file format: .DWG, .DXF, .VSD, or comparable) and three 11" x 17" prints of each drawing. When manufacturer's cutsheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawing shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cutsheets to fulfill submittal requirements. Select and show submittal quantities appropriate to scope of work. Submittal approval does not relieve Controls Contractor of responsibility to supply sufficient quantities to complete work. Submittals shall be provided within 12 weeks of contract award. Submittals shall include:

1. DDC System Hardware

- a. A complete bill of materials to be used indicating quantity, manufacturer, model number, and relevant technical data of equipment to be used.
- b. Manufacturer's description and technical data such as performance curves, product specifications, and installation and maintenance instructions for items listed below and for relevant items not listed below:
 - i. Direct digital controllers (controller panels)
 - ii. Transducers and transmitters
 - iii. Sensors (including accuracy data)
 - iv. Actuators
 - v. Valves
 - vi. Relays and switches
 - vii. Control panels
 - viii. Power supplies
 - ix. Batteries
 - x. Operator interface equipment
 - xi. Wiring
- c. Wiring diagrams and layouts for each control panel. Show termination numbers.
- d. Schematic diagrams for all field sensors and controllers. Provide floor plans of all sensor locations and control hardware. Riser diagrams showing control network layout, communication protocol, and wire types.

2. Central System Hardware and Software

- a. A complete bill of material of equipment used indicating quantity, manufacturer, model number, and relevant technical.
- b. Manufacturer's description and technical data such as product specifications and installation and maintenance instructions for items listed below and for relevant items furnished under this contract not listed below:
 - i. Central Processing Unit (CPU) or web server
 - ii. Monitors
 - iii. Keyboards
 - iv. Power supplies

- v. Battery backups
 - vi. Interface equipment between CPU or server and control panels
 - vii. Operating System software
 - viii. Operator interface software
 - ix. Color graphic software
 - x. Third-party software
 - c. Schematic diagrams for all control, communication, and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show interface wiring to control system.
 - d. Network riser diagrams of wiring between central control unit and control panels.
3. Controlled Systems
- a. Riser diagrams showing control network layout, communication protocol, and wire types.
 - b. A schematic diagram of each controlled system. The schematics shall have all control points labeled with point names shown or listed. The schematics shall graphically show the location of all control elements in the system.
 - c. A schematic wiring diagram of each controlled system. Label control elements and terminals. Where a control element is also shown on control system schematic, use the same name.
 - d. An instrumentation list (Bill of Materials) for each controlled system. List each control system element in a table. Show element name, type of device, manufacturer, model number, and product data sheet number.
 - e. A mounting, wiring, and routing plan-view drawing. The design shall take into account HVAC, electrical, and other systems' design and elevation requirements. The drawing shall show the specific location of any special wall bracing for panels to accommodate this work.
 - f. A complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system.
 - g. A point list for each control system. List I/O points and software points specified in Section 230940. Indicate alarmed and trended points.
4. Quantities of items submitted shall be reviewed but are the responsibility of the Controls Contractor.
5. A description of the proposed process along with all report formats and checklists to be used in Section 230900 Article 3.21, Control System Demonstration and Acceptance.
6. BACnet Protocol Implementation Conformance Statement (PICS) for each submitted type of controller and operator interface.

B. Schedules

- 1. Within one month of contract award, provide a schedule of the work indicating the following:
 - a. Intended sequence of work items
 - b. Start date of each work item
 - c. Duration of each work item
 - d. Planned delivery dates for ordered material and equipment and expected lead times

- e. Milestones indicating possible restraints on work by other trades or situations
 - 2. Monthly written status reports indicating work completed and revisions to expected delivery dates. Include updated schedule of work.
- C. Project Record Documents. Upon completion of installation, submit three copies of record (as-built) documents. In addition, submit the entire Operation and Maintenance Manual on Compact Disc media. The documents shall be submitted for approval prior to final completion and shall include:
- 1. Project Record Drawings. As-built versions of submittal shop drawings provided as AutoCAD compatible files on magnetic or optical media (file format: .DWG, .DXF, .VSD, or comparable) and as 11" x 17" prints.
 - 2. Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements of Section 230900 Article 3.21, Control System Demonstration and Acceptance.
 - 3. Operation and Maintenance (O&M) Manual. The Operation and Maintenance Manual CD shall be self-contained, and include all necessary software required to access the product data sheets. A logically organized table of contents shall provide dynamic links to view and print all product data sheets. Viewer software shall provide the ability to display, zoom, and search all documents.
 - 4. As-built versions of submittal product data.
 - 5. Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
 - 6. 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.
 - 7. Programming manual or set of manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
 - 8. 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.
 - 9. Documentation of programs created using custom programming language including setpoints, tuning parameters, and object database. Electronic copies of programs shall meet this requirement if control logic, setpoints, tuning parameters, and objects can be viewed using furnished programming tools.
 - 10. Graphic files, programs, and database on magnetic or optical media.
 - 11. List of recommended spare parts with part numbers and suppliers.
 - 12. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
 - 13. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation or web server software, and graphics software.
 - 14. Licenses, guarantees, and warranty documents for equipment and systems.
 - 15. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.

1.7 OWNERSHIP OF PROPRIETARY MATERIAL

- A. Project-specific software and documentation shall become Owner's property. This includes, but is not limited to:
1. Graphics
 2. Record drawings
 3. Database
 4. Application programming code
 5. Documentation

1.8 Definitions

Term	Definition
BACnet Interoperability Building Blocks (BIBB)	A BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBS are combined to build the BACnet functional requirements for
BACnet/BACnet Standard	BACnet communication requirements as defined by the latest version of ASHRAE/ANSI 135 and approved ad-
Control Systems Server	A computer(s) that maintain(s) the systems configuration and programming database.
Controller	Intelligent stand-alone control device. Controller is a generic reference to building controllers, custom application controllers, and application specific controllers.
Direct Digital Control	Microprocessor-based control including Analog/Digital conversion and program logic.
Gateway	Bi-directional protocol translator connecting control systems that use different communication protocols.
Local Area Network	Computer or control system communications network limited to local building or campus.
Master-Slave/Token Pass-Point-to-Point	Data link protocol as defined by the BACnet standard.
Primary Controlling LAN	Serial communication as defined in the BACnet standard.
Protocol Implementation Conformance Statement	High speed, peer-to-peer controller LAN connecting BCs and optionally AACs and ASCs. Refer to System Archi-
Router	A written document that identifies the particular options specified by BACnet that are implemented in a device.
Wiring	A device that connects two or more networks at the net-
	Raceway, fittings, wire, boxes and related items.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by Johnson Controls (Contact – Jonathan Greenberg, Jonathan.Greenberg@jci.com, (215) 421-1652).
- B. Hardware and System Software. Existing District workstation and web server shall be maintained and modified for the implementation of the project scope of work.

2.2 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.

2.3 COMMUNICATIONS

- A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135, BACnet.
- B. Install new wiring and network devices as required to provide a complete and workable control network.
- C. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.
- D. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
 - 1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.
 - 2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute control strategies specified in Section 230940. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.
- E. Workstations, Building Control Panels, and Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated device via the internetwork. The system shall automatically adjust for daylight saving and standard time as applicable.

- F. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring.

2.4 OPERATOR INTERFACE

- A. Operator Interface. Web server shall reside on high-speed network with building controllers. Each standard browser connected to server shall be able to access all system information. The Operator Workstation or server shall conform to the BACnet Operator Workstation (B-OWS) or BACnet Advanced Workstation (B-AWS) device profile as specified in ASHRAE/ANSI 135 BACnet Annex L.
- B. Communication. Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135, BACnet Annex J.

2.5 CONTROLLER SOFTWARE

- A. Furnish the following applications for building and energy management. All software application shall reside and operate in the system controllers. Applications shall be editable through operator workstation, web browser interface, or engineering workstation.
- B. Scheduling. Provide the capability to execute control functions according to a user created or edited schedule. Each schedule shall provide the following schedule options as a minimum:
 - 1. Weekly Schedule. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
 - 2. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule has executed, the system shall discard and replace the exception schedule with the standard schedule for that day of the week.
 - 3. Holiday Schedules. Provide the capability for the operator to define up to 24 special or holiday schedules. These schedules will be repeated each year. The operator shall be able to define the length of each holiday period.
- C. System Coordination. Operator shall be able to group related equipment based on function and location and to use these groups for scheduling and other applications.
- D. Binary Alarms. Each binary object shall have the capability to be configured to alarm based on the operator-specified state. Provide the capability to automatically and manually disable alarming.
- E. Analog Alarms. Each analog object shall have both high and low alarm limits. The operator shall be able to enable or disable these alarms.

- F. Alarm Reporting. The operator shall be able to determine the action to be taken in the event of an alarm. An alarm shall be able to start programs, print, be logged in the event log, generate custom messages, and display on graphics.
- G. Remote Communication. System shall automatically contact operator workstation or server on receipt of critical alarms. If no network connection is available, system shall use a modem connection.
- H. Maintenance Management. The system shall be capable of generating maintenance alarms when equipment exceeds adjustable runtime, equipment starts, or performance limits. Configure and enable maintenance alarms for each HVAC unit.
- I. Sequencing. Application software shall sequence HVAC equipment as specified in Section 230940 (Sequences of Operation).
- J. PID Control. System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs. The calculation interval, PID gains, and other tuning parameters shall be adjustable by a user with the correct security level.
- K. Staggered Start. System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.
- L. Energy Calculations.
 - 1. The system shall accumulate and convert instantaneous power (kW) or flow rates (gpm) to energy usage data.
 - 2. The system shall calculate a sliding-window average (rolling average). Operator shall be able to adjust window interval to 15 minutes, 30 minutes, or 60 minutes.
- M. Anti-Short Cycling. All binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.
- N. On and Off Control with Differential. Provide an algorithm that allows a binary output to be cycled based on a controlled variable and a setpoint. The algorithm shall be direct-acting or reverse-acting.
- O. Runtime Totalization. Provide software to totalize runtime for each binary input and output. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit. Configure and enable runtime totalization for each HVAC unit.

2.6 CONTROLLERS

- A. General. Provide an adequate number of Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), Smart Actuators (SA), and Smart Sensors (SS) as required to achieve performance

specified for System Performance. Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135, BACnet Annex L. Unless otherwise specified, hardwired actuators and sensors may be used in lieu of BACnet Smart Actuators and Smart Sensors.

B. BACnet.

1. Building Controllers (BCs). Each BC shall conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L, and shall be listed as a certified B-BC in the BACnet Testing Laboratories (BTL) Product Listing.
2. Advanced Application Controllers (AACs). Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing.
3. Application Specific Controllers (ASCs). Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.
4. Smart Sensors (SSs). Each SS shall conform to BACnet Smart Sensor (B-SS) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-SS in the BACnet Testing Laboratories (BTL) Product Listing.
5. BACnet Communication.
 - a. Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.
 - b. BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.
 - c. Each AAC shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
 - d. Each ASC shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
 - e. Each SA shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
 - f. Each SS shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using ARCNET or MS/TP Data Link/Physical layer protocol.

C. Communication

1. Service Port. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
2. Signal Management. BC and ASC operating systems shall manage input and output communication signals to allow distributed controllers to share

- real and virtual object information and to allow for central monitoring and alarms.
3. Data Sharing. Each BC and AAC shall share data as required with each networked BC and AAC.
 4. Stand-Alone Operation. Each piece of equipment specified in Section 23 09 93 shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network such as outdoor air conditions, supply air or water temperature coming from source equipment, etc.
- D. Environment. Controller hardware shall be suitable for anticipated ambient conditions.
1. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -20°F to 140°F.
 2. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 32°F to 120°F.
- E. Keypad. Provide a local keypad and display for each BC and AAC. Operator shall be able to use keypad to view and edit data. Keypad and display shall require password to prevent unauthorized use. If the manufacturer does not normally provide a keypad and display for each BC and AAC, provide the software and any interface cabling needed to use a laptop computer as a Portable Operator's Terminal for the system.
- F. Real-Time Clock. Controllers that perform scheduling shall have a real-time clock.
- G. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to a field-removable modular terminal strip or to a termination card connected by a ribbon cable. Each BC and AAC shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.
- H. Memory.
1. Controller memory shall support operating system, database, and programming requirements.
 2. Each BC and AAC shall retain BIOS and application programming for at least 72 hours in the event of power loss.
 3. Each ASC and SA shall use nonvolatile memory and shall retain BIOS and application programming in the event of power loss. System shall automatically download dynamic control parameters following power loss.
- I. Immunity to Power and Noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 feet.

- J. Transformer. ASC power supply shall be fused or current limiting and shall be rated at a minimum of 125% of ASC power consumption.

2.7 INPUT AND OUTPUT INTERFACE

- A. General. Hard-wire input and output points to BCs, AACs, ASCs, or SAs.
- B. Protection. All input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground shall cause no damage to the controller. All input and output points shall be protected from voltage up to 24 V of any duration, such that contact with this voltage will cause no controller damage.
- C. Binary Inputs. Binary inputs shall allow the monitoring of ON/OFF signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against contact bounce and noise. Binary inputs shall sense dry contact closure without application of power external to the controller.
- D. Pulse Accumulation Inputs. Pulse accumulation inputs shall conform to binary input requirements and shall also accumulate up to 10 pulses per second.
- E. Analog Inputs. Analog inputs shall allow the monitoring of low-voltage (0–10 Vdc), current (4–20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.
- F. Binary Outputs. Binary outputs shall provide for ON/OFF operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on Building Controllers shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.
- G. Analog Outputs. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0–10 Vdc or a 4–20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two-position (auto-manual) switch, a manually adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.
- H. Universal Inputs and Outputs. Inputs and outputs that can be designated as either binary or analog in software shall conform to the provisions of this section that are appropriate for their designated use.
- I. System Object Capacity. The system size shall be expandable to at least twice the number of input/ output objects required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The operator interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system

2.8 POWER SUPPLIES AND LINE FILTERING

- A. Power Supplies. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.
 - 1. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand 150% current overload for at least three seconds without trip-out or failure.
 - a. Unit shall operate between 32°F and 120°F. EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
 - b. Line voltage units shall be UL recognized and CSA listed.
- B. Power Line Filtering.
 - 1. Provide internal or external transient voltage and surge suppression for workstations and controllers. Surge protection shall have:
 - a. Dielectric strength of 1000 V minimum
 - b. Response time of 10 nanoseconds or less
 - c. Transverse mode noise attenuation of 65 dB or greater
 - d. Common mode noise attenuation of 150 dB or greater at 40–100 Hz

2.9 AUXILIARY CONTROL DEVICES

- A. Motorized Control Dampers, unless otherwise specified elsewhere, shall be as follow.
 - 1. Type. Control dampers shall be the parallel or opposed-blade type as specified below.
 - a. Outdoor and return air mixing dampers and face-and-bypass dampers shall be parallel-blade and shall direct airstreams toward each other.
 - b. Other modulating dampers shall be opposed-blade.
 - c. Two-position shutoff dampers shall be parallel- or opposed-blade with blade and side seals.
 - 2. Frame. Damper frames shall be 13 gauge galvanized steel channel or 0.125 in. extruded aluminum with reinforced corner bracing.
 - 3. Blades. Damper blades shall not exceed 8 inches in width or 48 inches in length. Blades shall be suitable for medium velocity (2000 fpm) performance. Blades shall be not less than 16 gauge.
 - 4. Shaft Bearings. Damper shaft bearings shall be as recommended by manufacturer for application, oil impregnated sintered bronze, or better.
 - 5. Seals. Blade edges and frame top and bottom shall have replaceable seals of butyl rubber or neoprene. Side seals shall be spring-loaded stainless steel. Blade seals shall leak no more than 10 cfm per ft² at 4 in. w.g. differential pressure. Blades shall be airfoil type suitable for wide-open face velocity of 1500 fpm.

6. Sections. Individual damper sections shall not exceed 48 inches × 60 inches. Each section shall have at least one damper actuator.
7. Modulating dampers shall provide a linear flow characteristic where possible.
8. Linkages. Dampers shall have exposed linkages.

B. Electric Damper and Valve Actuators.

1. Stall Protection. Mechanical or electronic stall protection shall prevent actuator damage throughout the actuator's rotation.
2. Spring-return Mechanism. Actuators used for power-failure and safety applications shall have an internal mechanical spring-return mechanism or an uninterruptible power supply (UPS).
3. Signal and Range. Proportional actuators shall accept a 0–10 Vdc or a 0–20 mA control signal and shall have a 2–10 Vdc or 4–20 mA operating range. (Floating motor actuators may be substituted for proportional actuators in terminal unit applications as described in paragraph 2.7H.)
4. Wiring. 24 Vac and 24 Vdc actuators shall operate on Class 2 wiring.
5. Manual Positioning. Operators shall be able to manually position each actuator when the actuator is not powered. Non-spring-return actuators shall have an external manual gear release. Spring-return actuators with more than 60 in.-lb torque capacity shall have a manual crank.

C. Control Valves.

1. Control valves shall be two-way or three-way type for two-position or modulating service as shown.
2. Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:
 - a. Water Valves:
 - i. Two-way: 150% of total system (pump) head.
 - ii. Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.
3. Water Valves.
 - a. Body and trim style and materials shall be in accordance with manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service.
 - b. Sizing Criteria:
 - i. Two-position service: Line size.
 - ii. Two-way modulating service: Pressure drop shall be equal to twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or 5 psi, whichever is greater.
 - iii. Three-way modulating service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), 5 psi maximum.
 - iv. Valves ½ in. through 2 in. shall be bronze body or cast brass ANSI Class 250, spring-loaded, PTFE packing, quick opening for two-position service. Two-way valves to have replaceable composition disc or stainless steel ball.
 - v. Valves 2½ in. and larger shall be cast iron ANSI Class 125 with guided plug and PTFE packing.

- c. Water valves shall fail normally open or closed, as follows:
 - i. Water zone valves—normally open preferred.
 - ii. Heating coils in air handlers—normally open.
 - iii. Chilled water control valves—normally closed.
 - iv. Other applications—as required by sequences of operation.

D. Binary Temperature Devices.

- 1. Low-Limit Thermostats. Low-limit airstream thermostats shall be UL listed, vapor pressure type. Element shall be at least 20 feet long. Element shall sense temperature in each 1 foot section and shall respond to lowest sensed temperature. Low-limit thermostat shall be manual reset only.

E. Temperature Sensors.

- 1. Type. Temperature sensors shall be Resistance Temperature Device (RTD) or thermistor.
- 2. Duct Sensors. Duct sensors shall be single point or averaging as shown. Averaging sensors shall be a minimum of 5 feet in length per 10 ft² of duct cross-section.
- 3. Immersion Sensors. Provide immersion sensors with a separable stainless steel well. Well pressure rating shall be consistent with system pressure it will be immersed in. Well shall withstand pipe design flow velocities.
 - a. When thermo wells are required, the sensor and well shall be supplied as a complete assembly.
 - b. Thermo wells and sensors shall be mounted in a threadolet or ½-inch NPT saddle and allow easy access to the sensor for repair or replacement.
- 4. Space Sensors. Space sensors shall have setpoint adjustment, override switch, and communication port (BACnet connection to DDC controller). Space sensors shall NOT have temperature display.
 - a. Setpoint reset slide switch providing a ±2 degree (adjustable) range.
 - b. Momentary override request push button allowing for activation of after-hours operation.
 - c. Setpoint adjustment and override switch not required for space sensors located in Corridors, Vestibules, Toilet Rooms, Storage Rooms, Mechanical Rooms and Electrical Rooms.
- 5. Differential Sensors. Provide matched sensors for differential temperature measurement.

F. Humidity Sensors.

- 1. Duct and room sensors shall have a sensing range of 20%–80%.
- 2. Duct sensors shall have a sampling chamber.
- 3. Outdoor air humidity sensors shall have a sensing range of 20%–95% RH and shall be suitable for ambient conditions of -40°F–120°F.
- 4. Humidity sensors shall not drift more than 1% of full scale annually.
- 5. Space sensors shall NOT have relative humidity display.

G. Carbon Dioxide Sensors.

- 1. Duct and room sensors shall have an output range of 0 to 2,000 ppm.

2. Repeatability shall be ± 20 ppm for 10%–100% of scale.
 3. Sensors shall have self-calibration algorithm for daily adjustment during unoccupied period and 5-year calibration interval.
 4. Space sensors shall NOT have carbon dioxide display.
- H. Flow Switches. Flow-proving switches shall be paddle (water service only) or differential pressure type (air or water service) as shown. Switches shall be UL listed, SPDT snap-acting, and pilot duty rated (125 VA minimum).
1. Paddle switches shall have adjustable sensitivity and NEMA 1 enclosure unless otherwise specified.
 2. Differential pressure switches shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.
- I. Relays.
1. Control Relays. Control relays shall be plug-in type, UL listed, and shall have dust cover and LED “energized” indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
 2. Time Delay Relays. Time delay relays shall be solid-state plug-in type, UL listed, and shall have adjustable time delay. Delay shall be adjustable $\pm 100\%$ from setpoint shown. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure for relays not installed in local control panel.
- J. Override Timers.
1. Unless implemented in control software, override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration required by application. Provide 0–6 hour calibrated dial unless otherwise specified. Flush mount timer on local control panel face or where shown.
- K. Current Transmitters.
1. AC current transmitters shall be self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4–20 mA two-wire output. Full-scale unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A, with internal zero and span adjustment. Unit accuracy shall be $\pm 1\%$ full-scale at 500 ohm maximum burden.
 2. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized.
 3. Unit shall be split-core type for clamp-on installation on existing wiring.
- L. Current Transformers.
1. AC current transformers shall be UL/CSA recognized and shall be completely encased (except for terminals) in approved plastic material.
 2. Transformers shall be available in various current ratios and shall be selected for $\pm 1\%$ accuracy at 5 A full-scale output.
 3. Use fixed-core transformers for new wiring installation and split-core transformers for existing wiring installation.

M. Voltage Transmitters.

1. AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4–20 mA output with zero and span adjustment.
2. Adjustable full-scale unit ranges shall be 100–130 Vac, 200–250 Vac, 250–330 Vac, and 400–600 Vac. Unit accuracy shall be $\pm 1\%$ full-scale at 500 ohm maximum burden.
3. Transmitters shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized at 600 Vac rating.

N. Voltage Transformers.

1. AC voltage transformers shall be UL/CSA recognized, 600 Vac rated, and shall have built-in fuse protection.
2. Transformers shall be suitable for ambient temperatures of 4°C–55°C (40°F–130°F) and shall provide $\pm 0.5\%$ accuracy at 24 Vac and 5 VA load.
3. Windings (except for terminals) shall be completely enclosed with metal or plastic.

O. Current Switches.

1. Current-operated switches shall be self-powered, solid-state with adjustable trip current. Select switches to match application current and DDC system output requirements.

P. Pressure Transducers.

1. Transducers shall have linear output signal and field-adjustable zero and span.
2. Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50% greater than calibrated span without damage.
3. Water pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 150 psi. Transducer shall have 4–20 mA output, suitable mounting provisions, and block and bleed valves.
4. Water differential pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 150 psi. Over-range limit (differential pressure) and maximum static pressure shall be 300psi. Transducer shall have 4–20 mA output, suitable mounting provisions, and 5-valve manifold.

Q. Differential Pressure Switches. Differential pressure switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum) and shall have scale range and differential suitable for intended application and NEMA 1 enclosure.

1. Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.

R. Pressure-Electric (PE) Switches.

1. Shall be metal or neoprene diaphragm actuated, operating pressure rated for 0–25 psig, with calibrated scale minimum setpoint range of 2–18 psig minimum, UL listed.
2. Provide one- or two-stage switch action (SPDT, DPST, or DPDT) as required by application. Electrically rated for pilot duty service (125 VA minimum) and/or for motor control.
3. Switches shall be open type (panel-mounted) or enclosed type for remote installation. Enclosed type shall be NEMA 1 unless otherwise specified.
4. Each pneumatic signal line to PE switches shall have permanent indicating gauge.

S. Local Control Panels.

1. All indoor control cabinets shall be fully enclosed NEMA 1 construction with (hinged door) key-lock latch and removable subpanels. A single key shall be common to all field panels and subpanels.
2. Interconnections between internal and face-mounted devices shall be prewired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600 volt service, individually identified per control/ interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
3. Provide ON/OFF power switch with overcurrent protection for control power sources to each local panel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. The Controls Contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started.
- B. The Controls Contractor shall examine the drawings and specifications for other parts of the work. If any discrepancies occur between the plans and the Controls Contractor's work and the plans and the work of others, the Controls Contractor shall report these discrepancies to the engineer and shall obtain written instructions for any changes necessary to accommodate the Controls Contractor's work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect of the Controls Contractor to report such discrepancies shall be made by, and at the expense of this Controls Contractor.

3.2 PROTECTION

- A. The Controls Contractor shall protect all work and material from damage by his/her work or employees and shall be liable for all damage thus caused.
- B. The Controls Contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The Controls Contractor shall protect any material that is not immediately installed. The Controls Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.3 COORDINATION

- A. Site
 - 1. Where the mechanical work will be installed in close proximity to, or will interfere with, work of other trades, the Controls Contractor shall assist in working out space conditions to make a satisfactory adjustment. If the Controls Contractor installs his/her work before coordinating with other trades, so as to cause any interference with work of other trades, the Controls Contractor shall make the necessary changes in his/her work to correct the condition without extra charge.
 - 2. Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.
- B. Test and Balance.
 - 1. The Controls Contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.
 - 2. The Controls Contractor shall provide training in the use of these tools. This training will be planned for a minimum of 4 hours.

3. In addition, the Controls Contractor shall provide a qualified technician to assist in the test and balance process, until the first 20 terminal units are balanced.
 4. The tools used during the test and balance process will be returned at the completion of the testing and balancing.
- C. Life Safety.
1. Duct smoke detectors required for air handler shutdown are provided by the Electrical Contractor. Interlock smoke detectors to air handlers for shutdown as specified in Section 230940 (Sequences of Operation).
- D. Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated by the Controls Contractor as follows:
1. The Controls Contractor shall coordinate and resolve any incompatibility issues that arise between control products provided under this section and those provided under other sections or divisions of this specification.
 2. The Controls Contractor is responsible for providing all controls described in the contract documents regardless of where within the contract documents these controls are described.
 3. The Controls Contractor is responsible for the interface of control products provided by multiple suppliers regardless of where this interface is described within the contract documents.

3.4 GENERAL WORKMANSHIP

- A. Install equipment, piping, and wiring/raceway parallel to building lines (i.e. horizontal, vertical, and parallel to walls) wherever possible.
- B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- C. Install equipment in readily accessible locations as defined by Chapter 1 Article 100 Part A of the National Electrical Code (NEC).
- D. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
- E. All equipment, installation, and wiring shall comply with industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.5 FIELD QUALITY CONTROL

- A. All work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes and ordinances.

- B. Controls Contractor shall continually monitor the field installation for code compliance and quality of workmanship.
- C. Controls Contractor shall have work inspection by local and/or state authorities having jurisdiction over the work.

3.6 WIRING AND RACEWAYS

- A. All control and interlock wiring shall comply with national and local electrical codes, and Division 26 of this specification, Where the requirements of this section differ from Division 26, the requirements of this section shall take precedence.
- B. All NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway according to NEC and Division 26 requirements.
 - 1. Power wiring shall use insulated copper conductors, minimum 12 gauge, and shall be UL listed for 200°F minimum service.
 - 2. Power wiring shall be installed in conduit and separated from any other wiring.
 - 3. The 120 VAC circuit for control locations shall be powered by a dedicated power source.
 - 4. The power wiring between the junction box and the control transformer shall be furnished and installed by the Controls Contractor. Refer to HVAC Drawings for locations of ATC panels. Junction boxes shall be provided by the Electrical Contractor at each ATC panel location.
- C. All low-voltage wiring shall meet NEC Class 2 requirements. Low-voltage power circuits shall be subfused when required to meet Class 2 current limit.
- D. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in raceway may be used provided that cables are UL listed for the intended application.
- E. All wiring in mechanical, electrical, or service rooms, or where subject to mechanical damage, shall be installed in raceway at levels below 10 feet.
- F. All wiring located outdoors shall be installed in conduit with weatherproof mounting or junction boxes with weatherproof covers and gaskets.
- G. Do not install Class 2 wiring in raceways containing Class 1 wiring. Boxes and panels containing high-voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).
- H. Do not install wiring in raceway containing tubing.
- I. Where Class 2 wiring is run exposed, wiring is to be run parallel along a surface or perpendicular to it and neatly tied at 10 foot intervals.

- J. Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.
- K. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block.
- L. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- M. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, the Controls Contractor shall provide step-down transformers.
- N. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.
- O. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.
- P. Size of raceway and size and type of wire type shall be the responsibility of the Controls Contractor in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.
- Q. Include one pull string in each raceway 1 inch or larger.
- R. Use color-coded conductors throughout with conductors of different colors.
- S. Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.
- T. Conceal all raceways except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 6 inches from high-temperature equipment (e.g. flues).
- U. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.
- V. Adhere to this specification's Division 26 requirements where raceway crosses building expansion joints.
- W. Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of vertical raceways.
- X. The Controls Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.
- Y. Flexible metal raceways and liquid-tight flexible metal raceways shall not exceed 3 feet in length and shall be supported at each end. Flexible metal raceway less than

½ in. electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.

- Z. Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes and ends not terminating in boxes shall have bushings installed.

3.7 COMMUNICATION WIRING

- A. The Controls Contractor shall adhere to the items listed in the "Wiring and Raceways" article in Part 3 of the specification.
- B. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling
- C. Do not install communication wiring in raceways and enclosures containing Class 1 or other Class 2 wiring.
- D. Maximum pulling, tension, and bend radius for the cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.
- E. Controls Contractor shall verify the integrity of the entire network following cable installation. Use appropriate test measures for each particular cable.
- F. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lightning arrestor shall be installed according to manufacturer's instructions.
- G. All runs of communication wiring shall be unspliced length when that length is commercially available.
- H. All communication wiring shall be labeled to indicate origination and destination data.
- I. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."
- J. BACnet MS/TP communications wiring shall be installed in accordance with ASHRAE/ANSI Standard 135. This includes but is not limited to:
 - 1. The network shall use shielded, twisted-pair cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors shall be less than 100 pF per meter (30 pF per foot.)
 - 2. The maximum length of an MS/TP segment is 1200 meters (4000 ft) with AWG 18 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.
 - 3. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.
 - 4. An MS/TP EIA-485 network shall have no T connections.

3.8 INSTALLATION OF SENSORS

- A. Install sensors in accordance with the manufacturer's recommendations.
- B. Mount sensors rigidly and adequately for environment within which the sensor operates.
- C. Room temperature sensors shall be installed on concealed junction boxes properly supported by wall framing. Surface mounting is acceptable in mechanical and utility spaces.
 - 1. Provide lockable tamper-proof covers in the Auditorium, Gymnasiums, Locker Rooms, and Cafeteria.
 - 2. Provide stainless steel plates for concealed thermistors in Corridors, Vestibules and Toilet Rooms.
- D. All wires attached to sensors shall be sealed in their raceways or in the wall to stop air transmitted from other areas from affecting sensor readings.
- E. Sensors used in mixing plenums and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.
- F. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 1 foot of sensing element for each 1 ft² of coil area.
- G. All pipe-mounted temperature sensors shall be installed in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells.
- H. Install outdoor air temperature sensors on north wall, complete with solar shield. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.
- I. Differential Air Static Pressure.
 - 1. Supply Duct Static Pressure. Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor (if applicable) or to the location of the duct high-pressure tap and leave open to the plenum.
 - 2. Return Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Pipe the low-pressure port to a tee in the low-pressure tap tubing of the corresponding building static pressure sensor.
 - 3. Building Static Pressure. Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe the high-pressure port to a location behind a thermostat cover.
 - 4. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
 - 5. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on

ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.

6. All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shut-off valves installed before the tee.
- J. Smoke detectors, freezestats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status.

3.9 FLOW SWITCH INSTALLATION

- A. Use correct paddle for pipe diameter.
- B. Adjust flow switch according to manufacturer's instructions.

3.10 ACTUATORS

- A. General. Mount and link control damper actuators according to manufacturer's instructions.
 1. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.
 2. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
 3. Provide all mounting hardware and linkages for actuator installation.
- B. Electric/Electronic
 1. Dampers: Actuators shall be direct mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5° travel available for tightening the damper seal. Actuators shall be mounted following manufacturer's recommendations.
 2. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

3.11 CONTROL VALVE INSTALLATION

- A. Valve submittals shall be coordinated for type, quantity, size, and piping configuration to ensure compatibility with pipe design.
- B. Slip-stem control valves shall be installed so that the stem position is not more than 60 degrees from the vertical up position. Ball type control valves shall be installed with the stem in the horizontal position.

- C. Valves shall be installed in accordance with the manufacturer's recommendations.
- D. Control valves shall be installed so that they are accessible and serviceable and so that actuators may be serviced and removed without interference from structure or other pipes and/or equipment.
- E. Isolation valves shall be installed so that the control valve body may be serviced without draining the supply/return side piping system. Unions shall be installed at all connections to screw-type control valves.
- F. Provide tags for all control valves indicating service and number. Tags shall be brass, 1.5 inch in diameter, with ¼ inch high letters. Securely fasten with chain and hook. Match identification numbers as shown on approved controls shop drawings.

3.12 CONTROL DAMPER INSTALLATION

- A. Damper submittals shall be coordinated for type, quantity, and size to ensure compatibility with sheet metal design.
- B. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting. Duct openings shall measure ¼ in. larger than damper dimensions and shall be square, straight, and level.
- C. Individual damper sections, as well as entire multiple section assemblies, must be completely square and free from racking, twisting, or bending. Measure diagonally from upper corners to opposite lower corners of each damper section. Both dimensions must be within 0.125 inches of each other.
- D. Follow the manufacturer's instructions for field installation of control dampers. Unless specifically designed for vertical blade application, dampers must be mounted with blade axis horizontal.
- E. Install extended shaft or jackshaft according to manufacturer's instructions. (Typically, a sticker on the damper face shows recommended extended shaft location. Attach shaft on labeled side of damper to that blade.)
- F. Damper blades, axles, and linkage must operate without binding. Before system operation, cycle damper after installation to ensure proper operation. On multiple section assemblies, all sections must open and close simultaneously.
- G. Provide a visible and accessible indication of damper position on the drive shaft end.
- H. Support ductwork in area of damper when required to prevent sagging due to damper weight.
- I. After installation of low-leakage dampers with seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.

3.13 DUCT SMOKE DETECTION

- A. Submit data for coordination of duct smoke detector interface to HVAC systems as required in Part 1, "Submittals."
- B. The Controls Contractor shall provide a dry-contact alarm output in the same room as the HVAC equipment to be controlled.

3.14 WARNING LABELS

- A. Permanent warning labels shall be affixed to all equipment that can be automatically started by the control system.
 - 1. Labels shall use white lettering (12-point type or larger) on a red background.
 - 2. Warning labels shall read as follows.

C A U T I O N

This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.

- B. Permanent warning labels shall be affixed to all motor starters and control panels that are connected to multiple power sources utilizing separate disconnects.
 - 1. Labels shall use white lettering (12-point type or larger) on a red background.
 - 2. Warning labels shall read as follows.

C A U T I O N

This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.

3.15 IDENTIFICATION OF HARDWARE AND WIRING

- A. All wiring and cabling, including that within factory-fabricated panels shall be labeled at each end within 2 inches of termination with control system address or termination number.
- B. Permanently label or code each point of field terminal strips to show the instrument or item served.
- C. Identify control panels with minimum ½ inch letters on laminated plastic nameplates.
- D. Identify all other control components with permanent labels. All plug-in components shall be labeled such that label removal of the component does not remove the label.
- E. Identify room sensors related to terminal boxes or valves with nameplates or permanent labels mounted on sensor covers.
- F. Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.

- G. Identifiers shall match record documents.

3.16 CONTROLLERS

- A. Provide a separate controller for each AHU or other HVAC system. A DDC controller may control more than one system provided that all points associated with the system are assigned to the same DDC controller. Points used for control loop reset, such as outside air or space temperature, are exempt from this requirement.
- B. Building Controllers and Custom Application Controllers shall be selected to provide the required I/O point capacity required to monitor all of the hardware points listed in Section 230940 (Sequences of Operation).

3.17 PROGRAMMING

- A. Provide sufficient internal memory for the specified sequences of operation and trend logging.
- B. Point Naming. Name points as shown on the equipment points list provided with each sequence of operation. See Section 230940 (Sequences of Operation). If character limitations or space restrictions make it advisable to shorten the name, abbreviations may be used where identified with an Abbreviations List in the Controls Submittal. Where multiple points with the same name reside in the same controller, each point name may be customized with its associated Program Object number. For example, "Zone Temp 1" for Zone 1, "Zone Temp 2" for Zone 2.
- C. Software Programming.
 - 1. Provide programming for the system and adhere to the sequences of operation provided. All other system programming necessary for the operation of the system, but not specified in this document, also shall be provided by the Controls Contractor. Embed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation. Use the appropriate technique based on the following programming types:
 - a. Text-based:
 - i. Must provide actions for all possible situations
 - ii. Must be modular and structured
 - iii. Must be commented
 - b. Graphic-based:
 - i. Must provide actions for all possible situations
 - ii. Must be documented
 - c. Parameter-based:
 - i. Must provide actions for all possible situations
 - ii. Must be documented.
- D. Operator Interface.
 - 1. Standard Graphics. Provide graphics for all mechanical systems and floor plans of the building. This includes each chilled water system, hot water

system, chiller, boiler, air handler, and all terminal equipment. Point information on the graphic displays shall dynamically update. Show on each graphic all relevant input and output points for that equipment. Also show relevant calculated points such as setpoints. As a minimum, show on each equipment graphic the input and output points and relevant calculated points as indicated on the applicable Points List in Section 230940.

2. The Controls Contractor shall provide all the labor necessary to install, initialize, start up, and troubleshoot all operator interface software and its functions as described in this section. This includes any operating system software, the operator interface database, and any third-party software installation and integration required for successful operation of the operator interface.

3.18 START-UP AND CHECKOUT PROCEDURES

- A. Start up, check out, and test all hardware and software and verify communication between all components.
 1. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
 2. Verify that all analog and binary input/output points read properly.
 3. Verify alarms and interlocks.
 4. Verify operation of the integrated system.

3.19 CONTROL SYSTEM CHECKOUT AND TESTING

- A. Startup Testing. All testing listed in this article shall be performed by the contractor and shall make up part of the necessary verification of an operating control system. **This testing shall be completed before the Owner's representative and Design Engineer is notified of the Control System Demonstration.**
 1. The Controls Contractor shall furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.
 2. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
 3. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures according to manufacturers' recommendations.
 4. Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.
 5. Verify that all analog output devices (I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. The Controls Contractor shall check all control valves and automatic dampers to ensure proper action and closure. The Controls Contractor shall make any necessary adjustments to valve stem and damper blade travel.
 6. Verify that the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops.

7. Alarms and Interlocks:
 - a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
 - b. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
 - c. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

3.20 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Demonstration.

1. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Controls Contractor has completed the installation, started up the system, and performed his/her own tests.
2. The tests described in this section are to be performed in addition to the tests that the Controls Contractor performs as a necessary part of the installation, start-up, and debugging process and as specified in the "Control System Checkout and Testing" article in Part 3 of this specification. **The Owner and Design Engineer shall be notified at least 10 days in advance of the Control System Demonstration.**
3. The demonstration process shall follow that approved in Part 1, "Submittals." The approved checklists and forms shall be completed for all systems as part of the demonstration.
4. The Controls Contractor shall provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the Controls Contractor.
5. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.
6. Demonstrate compliance with Part 1, "System Performance."
7. Demonstrate compliance with sequences of operation through all modes of operation.
8. Demonstrate complete operation of operator interface.
9. Additionally, the following items shall be demonstrated:
 - a. DDC loop response. The Controls Contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in set point, which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under-

- damped or over-damped control shall require further tuning by the Controls Contractor.
- b. Demand limiting. The Controls Contractor shall supply a trend data output showing the action of the demand limiting algorithm. The data shall document the action on a minute-by-minute basis over at least a 30-minute period. Included in the trend shall be building kW, demand limiting set point, and the status of sheddable equipment outputs.
 - c. Optimum start/stop. The Controls Contractor shall supply a trend data output showing the capability of the algorithm. The change-of-value or change-of-state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.
 - d. Interface to the building fire alarm system.
 - e. Operational logs for each system that indicate all set points, operating points, valve positions, mode, and equipment status shall be submitted to the architect/engineer. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.
10. Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The Controls Contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

B. Acceptance.

- 1. All tests described in this specification shall have been performed to the satisfaction of both the engineer and owner prior to the acceptance of the control system as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the Controls Contractor may be exempt from the completion requirements if stated as such in writing by the engineer. Such tests shall then be performed as part of the warranty.
- 2. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Part 1, "Submittals."

3.21CLEANING

- A. The Controls Contractor shall clean up all debris resulting from his/her activities daily. The Controls Contractor shall remove all cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.
- B. At the completion of work in any area, the Controls Contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.
- C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.22 TRAINING

- A. Provide training for a designated staff of Owner's representatives. Training shall be provided via self-paced training, web-based or computer-based training, classroom training, or a combination of training methods
- B. Materials: Submit course outline for each class at least six weeks before first class.
- C. Multiple Training Sessions:
 - 1. The initial training session shall include a building walk-through. The Controls Contractor shall review the location of all control panels and devices including controls equipment located above ceilings.
 - 2. Training shall be conducted in four (4) 4-hour sessions on non-consecutive days and shall be fully coordinated with the Owner.
 - 3. Training shall be furnished via instructor-led sessions and include computer-based training.
 - 4. Coordinate schedule for each training session with the Owner, Engineer and SitelogIQ Energy Services at least 7 days in advance.
- D. Training shall enable students to accomplish the following objectives.
 - 1. Day-to-day Operators:
 - a. Proficiently operate the system
 - b. Understand control system architecture and configuration
 - c. Understand DDC system components
 - d. Understand system operation, including DDC system control and optimizing routines (algorithms)
 - e. Operate the workstation and peripherals
 - f. Log on and off the system
 - g. Access graphics, point reports, and logs
 - h. Adjust and change system set points, time schedules, and holiday schedules
 - i. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
 - j. Understand system drawings and Operation and Maintenance manual
 - k. Understand the job layout and location of control components
 - l. Access data from DDC controllers and ASCs
 - m. Operate portable operator's terminals
 - 2. Advanced Operators:
 - a. Make and change graphics on the workstation
 - b. Create, delete, and modify alarms, including annunciation and routing of these
 - c. Create, delete, and modify point trend logs and graph or print these both on an ad-hoc basis and at user-definable time intervals
 - d. Create, delete, and modify reports
 - e. Add, remove, and modify system's physical points
 - f. Create, modify, and delete programming
 - g. Add panels when required
 - h. Add operator interface stations

- i. Create, delete, and modify system displays, both graphical and others
 - j. Perform DDC system field checkout procedures
 - k. Perform DDC controller unit operation and maintenance procedures
 - l. Perform workstation and peripheral operation and maintenance procedures
 - m. Perform DDC system diagnostic procedures
 - n. Configure hardware including PC boards, switches, communication, and I/O points
 - o. Maintain, calibrate, troubleshoot, diagnose, and repair hardware
 - p. Adjust, calibrate, and replace system components
- 3. System Managers/Administrators:
 - a. Maintain software and prepare backups
 - b. Interface with job-specific, third-party operator software
 - c. Add new users and understand password security procedures
- E. Organize the training into sessions or modules for the three levels of operators listed above. (Day-to-Day Operators, Advanced Operators, System Managers and Administrators). Students will receive one or more of the training packages, depending on knowledge level required.
- F. Provide one copy of training material per student.
- G. The instructor(s) shall be factory-trained and experienced in presenting this material.
- H. Classroom training shall be done using a network of working controllers representative of installed hardware.

END OF SECTION 230900

SECTION 230940 - SEQUENCE OF OPERATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. All Division 23 sections.

1.2 SUMMARY

- A. This Section includes control sequences for the HVAC systems at each building included in the project.
- B. The sequence of operation requires controls coordination with the selected DOAS and RTU equipment manufacturer. Related items include but are not limited to:
 - 1. Cooling control
 - a. Direct BAS staging / speed modulation of compressors, OR
 - b. BAS output for supply air temperature setpoint and unitary control for staging / speed modulation of compressors
 - 2. Dehumidification control
 - a. Direct BAS staging / speed modulation of compressors based on evaporator coil suction pressure, OR
 - b. BAS output for evaporator coil discharge air temperature setpoint and unitary control for staging / speed modulation of compressors
 - 3. Hot gas reheat control
 - a. Direct control of hot gas reheat valve, OR
 - b. BAS output for supply air temperature setpoint and unitary control for hot gas reheat
 - 4. Heating control
 - a. Direct BAS modulation of hot water control valve, OR
 - b. BAS output for supply air temperature setpoint and unitary control for hot water coil control valve modulation
 - 5. Energy wheel defrost controls
 - a. Factory mounted and wired including integral thermostat and timer, OR
 - b. Factory controls with wheel VFD speed control based on the outside air temperature and the pressure drop across the wheel

1.3 DREXEL HILL MIDDLE SCHOOL AUDITORIUM AND STAGE - SINGLE ZONE ROOFTOP AIR HANDLING UNITS WITH DX COOLING AND HOT WATER HEATING COIL (RTU-1 AND RTU-2)

- A. General: The unit shall be controlled from a local DDC controller that shall perform temperature, dehumidification control, and ventilation functions. The unit shall operate

on scheduled occupancy and to maintain setback / setup temperatures during scheduled unoccupied periods.

- B. Optimal Start: The BAS shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period.
- C. Zone Sensor Adjustments:
 - 1. Zone setpoint shall be controlled only through the BAS and shall not be locally adjustable. The space temperature shall not be displayed at the zone sensor.
 - 2. Zone Unoccupied Override: The occupant shall be able to override the schedule and place the unit into an occupied mode for an adjustable period of time using the zone sensor timed override control. When the 'Manual On' button is depressed once, the Occupied LED shall turn on and the occupied heating / cooling setpoints shall take effect for 30 minutes (60 minutes when pressed twice, 90 minutes when pressed three times). At the expiration of this time, control of the unit shall automatically return to the schedule.
- D. Zone Temperature Setpoints:
 - 1. Occupied Mode: The unit shall maintain 75°F (adj.) cooling setpoint and 70°F (adj.) heating setpoint.
 - 2. Unoccupied Mode (night setback): The unit shall maintain 60°F (adj.) heating setpoint.
 - 3. BAS alarms shall be provided as follows:
 - a. High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
 - b. Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).
- E. Supply and Exhaust Fans: The supply and exhaust fans shall run anytime the unit is commanded to run, unless shutdown on safeties. A current switch on each fan shall input the fan status to the controller. BAS alarms shall be provided as follows:
 - 1. Supply or Exhaust Fan Failure: Commanded on, but the status is off.
 - 2. Supply or Exhaust Fan in Hand: Commanded off, but the status is on.
 - 3. Supply Fan VFD Fault.
- F. Supply Fan Speed Control: At cooling or heating demands less than 50%, modulate the supply fan VFD speed to two-thirds of the full fan speed to comply with ASHRAE Standard 90.1.
- G. Exhaust Fan Speed Control: Modulate the exhaust fan VFD speed to track the supply fan speed with an offset. The fan speed offset shall be determined during air balancing based on the scheduled design supply and exhaust airflows. When in economizer operation, increase the exhaust fan speed signal to track the economizer signal but not exceed the supply fan signal.
- H. Energy Wheel: The energy wheel shall be enabled for heating recovery mode whenever:
 - 1. The heating mode is active,

2. AND the supply fan status is on,
3. AND the exhaust fan status is on.

The energy wheel shall be enabled for cooling recovery mode whenever:

4. Building exhaust air dewpoint is below the outside air dewpoint temperature,
5. AND the cooling mode is active,
6. AND the supply fan status is on,
7. AND the exhaust fan status is on.

The wheel bypass damper shall be normally closed. When the energy wheel is commanded off for economizer operation, the wheel bypass damper shall open.

A current switch on the energy wheel shall input the wheel status to the controller. BAS alarms shall be provided as follows:

8. Energy Wheel Failure: Commanded on, but the status is off.
9. Energy Wheel in Hand: Commanded off, but the status is on.

Energy wheel defrost controls shall be either:

10. Factory mounted and wired including integral thermostat and timer. When the ambient temp drops below 35°F, the wheel shall stop every 30 minutes (adj.) for 2 minutes (adj.) to defrost/warm up in the exhaust airstream.
 11. Factory controls with wheel VFD speed control based on the outside air temperature and the pressure drop across the wheel. If the outdoor air temperature is below 5°F (adj.) and the differential pressure across the wheel is about 1.5" (adj.) frost control will enable and modulate the wheel VFD down to a slow rotational speed.
- I. DX Cooling: Energize and modulate DX cooling stages to maintain the space cooling temperature setpoint. One or more compressors shall be variable capacity digital scroll type with modulating capacity control. One or more compressors shall be on / off control. Cooling shall be enabled whenever:
1. Outside air temperature is greater than 60°F (adj.),
 2. AND the economizer is disabled or fully open,
 3. AND the supply fan status is on,
 4. AND the heating is not active.
- J. Heating Valve and Freeze Protection Pump Control: Modulate the heating coil control valve to maintain the space heating temperature setpoint. Energize the freeze protection pump when the outside air temperature is less than 40°F (adj.), or when the heating coil control valve is commanded open. The heating shall be enabled whenever:
1. The economizer is disabled,
 2. AND the supply fan status is on.
- K. Economizer: Disable the energy wheel, open the wheel bypass damper, and modulate the economizer dampers in sequence to maintain the space cooling setpoint based on the space temperature and the mixed air temperature.
1. The economizer shall be enabled whenever:
 - a. Outside air temperature is less than 65°F (adj.),

- b. AND the outside air enthalpy is less than 25 Btu/lb (adj.),
 - c. AND the outside air temperature is less than the return air temperature,
 - d. AND the outside air enthalpy is less than the zone enthalpy,
 - e. AND the supply fan status is on.
 2. The economizer shall close whenever:
 - a. Mixed air temperature drops from 48°F to 43°F (adj.),
 - b. OR on loss of supply fan status.
 3. The economizer shall be integrated with mechanical cooling and capable of providing partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load.
- L. Minimum Outside Air Ventilation - Carbon Dioxide (CO₂) Control: The BAS shall measure the zone CO₂ level. The controller shall modulate the outside air damper open on rising CO₂ concentrations, overriding normal damper operation to maintain a CO₂ setpoint of 900 ppm (adj.). The outside air damper shall not open at a rate greater than 2 percent per minute (adj.). When the CO₂ setpoint is satisfied, reduce the outside air damper to 10% (adj.) minimum position and disable the exhaust fan and energy wheel. BAS alarms shall be provided as follows:
 1. High Zone Carbon Dioxide Concentration: If the zone CO₂ concentration is greater than 1200 ppm (adj.).
- M. Dehumidification: If the space dew point temperature (based on BAS conversion of space temperature and relative humidity readings) exceeds 58°F (adj.), enable dehumidification operation to lower the space dew point temperature below 55°F (adj.). Coordinate with the RTU manufacturer which compressor circuit(s) are connected to the hot gas reheat coil. Modulate the associated compressor circuit(s) to maintain the manufacturer's recommended evaporator coil suction pressure and saturation temperature. The suction pressure sensors shall be factory mounted by the RTU manufacturer. If recommended by the RTU manufacturer, modulate the associated compressor circuit(s) to maintain the evaporator coil discharge air temperature sensor setpoint (55°F, adj.) if evaporator coil suction pressure measurement is not provided by the manufacturer. Energize and modulate the hot gas reheat to maintain the space heating temperature setpoint. If after a time delay (20 minutes, adj.) the space dew point temperature remains above setpoint, enable additional compressor circuit(s). If the hot water system is enabled and the hot gas reheat is insufficient, modulate the heating coil control valve to maintain the space heating temperature setpoint. Dehumidification shall be enabled whenever:
 1. Outside air temperature is greater than 60°F (adj.),
 2. AND space air temperature is greater than 70°F (adj.),
 3. AND the supply fan status is on,
 4. AND the heating mode is not active,
 5. AND the cooling mode is not active.
- N. Mixed Air Temperature: The controller shall monitor the mixed air temperature and use as required for economizer control. BAS alarms shall be provided as follows:
 1. High Mixed Air Temp: If the mixed air temperature is greater than 90°F (adj.).
 2. Low Mixed Air Temp: If the mixed air temperature is less than 45°F (adj.).

- O. Zone Relative Humidity: The BAS shall measure the zone relative humidity and calculate the zone dew point air temperature. The controller shall use the input values as required for humidity control. BAS alarms shall be provided as follows:
1. High Zone Relative Humidity: If the zone relative humidity is greater than 68% (adj.).
 2. High Zone Dew Point Air Temp: If the zone dew point air temperature is greater than 63°F (adj.).
- P. Return Air Temperature: The controller shall monitor the return air temperature and use as required for setpoint control or economizer control. BAS alarms shall be provided as follows:
1. High Return Air Temp: If the return air temperature is greater than 90°F (adj.).
 2. Low Return Air Temp: If the return air temperature is less than 45°F (adj.).
- Q. Exhaust Air Temperature (entering wheel): The controller shall monitor the building exhaust air dew point temperature. BAS alarms shall be provided as follows:
1. High Exhaust Air Dew Point Temp: If the exhaust air dew point temperature is greater than 63°F (adj.).
- R. Energy Wheel Leaving Air Temperature: The controller shall monitor the energy wheel leaving air temperature (outside airstream). BAS alarms shall be provided as follows:
1. High Mixed Air Temp: If the energy wheel leaving air temperature is greater than 90°F (adj.).
 2. Low Mixed Air Temp: If the energy wheel leaving air temperature is less than 40°F (adj.).
- S. Outdoor Air Temperature and Humidity: The controller shall monitor the outdoor air temperature and dew point temperature.
- T. Supply Air Temperature: The controller shall monitor the supply air temperature. Alarms shall be provided as follows:
1. High Supply Air Temp: If the supply air temperature is greater than 100°F (adj.).
 2. Low Supply Air Temp: If the supply air temperature is less 48°F (adj.).
- U. Unoccupied: The supply and exhaust fans shall be normally de-energized. The outside air damper shall be normally closed and the return air damper open.
1. Heating Mode: If the space temperature falls below the unoccupied setpoint of 55°F (adj.), the supply fan shall be energized and the outside air damper shall remain closed. Modulate the heating coil control valve to maintain the space heating temperature setpoint. As the space temperature setpoint is satisfied, the fan shall be de-energized.
 2. Dehumidification Mode: If the space dew point temperature (based on BAS conversion of space temperature and relative humidity readings) exceeds 58°F (adj.), energize the supply fan and enable dehumidification operation (similar to occupied dehumidification sequence) to lower the space dew point temperature below 55°F (adj.). Unoccupied dehumidification shall be enabled whenever:
 - a. Outside air temperature is greater than 60°F (adj.),
 - b. AND space air temperature is greater than 70°F (adj.).

V. Safeties:

1. Supply and Return Air Smoke Detection: Disable the supply and exhaust fans via a hard wired shutdown circuit and generate an alarm upon receiving a supply or return air smoke detected status.
2. Freeze Protection Pump Control: Energize the freeze protection pump when the outside air temperature is less than 40°F (adj.).
3. Low Mixed Air Temperature in Unoccupied Mode or Loss of Airflow: Modulate heating coil control valve to maintain mixed air temperature setpoint of 50°F (adj.). The supply fan shall remain de-energized unless the space temperature falls below the unoccupied setpoint. The outside air damper shall remain closed. The same sequence shall apply when status is lost for the supply fan in occupied mode.
4. Freezestats: Disable the supply fan via a hard wired shutdown circuit and generate an alarm upon receiving a freezestat status. Open the heating coil control valve. Provide freezestats located on the leaving side of the heating coil. Alarm shall be manual reset.
5. Low Evaporator Suction Temperature: Disable the compressors and generate an alarm when the suction line temperature falls below 35°F.

W. Digital Inputs

1. Supply Fan Status
2. Exhaust Fan Status
3. Energy Wheel Status
4. Supply Duct Smoke Detector
5. Return Duct Smoke Detector
6. Zone Unoccupied Override
7. Freezestat
8. Unit Fault Alarm

X. Analog Inputs

1. Space Temperature and Relative Humidity
2. Space CO2 Concentration
3. Evaporator Coil Suction Pressure or Evaporator Coil Discharge Air Temperature (as applicable)
4. Evaporator Suction Temperature
5. Supply Air Temperature
6. Mixed Air Temperature
7. Return Air Temperature
8. Building Exhaust Air Dew Point Temperature (entering wheel)
9. Energy Wheel Leaving Air Temperature
10. Compressor Amperage (each)
11. Hot Water Return Temperature - RTU

Y. Digital Outputs

1. Supply Fan Command
2. Exhaust Fan Command
3. Energy Wheel Command
4. Compressor Command (each)
5. Freeze Protection Pump

6. Wheel Bypass Damper

Z. Analog Outputs

1. Supply Fan Speed
2. Exhaust Fan Speed
3. Compressor Speed (variable capacity circuit)
4. Energy Wheel Speed
5. Hot Gas Reheat Control Valve
6. Heating Coil Valve
7. Economizer Dampers

1.4 DREXEL HILL MIDDLE SCHOOL LOCKER ROOMS - ROOFTOP DEDICATED OUTDOOR AIR UNITS WITH HOT WATER HEATING COIL AND NO MECHANICAL COOLING (DOAS-1 AND DOAS-2)

- A. General: The unit shall be controlled from a local DDC controller that shall perform temperature and ventilation functions. The unit shall operate on scheduled occupancy and to maintain setback temperature control during scheduled unoccupied periods.
- B. Optimal Start: The BAS shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up period while still achieving comfort conditions by the start of scheduled occupied period.
- C. Supply and Exhaust Fans: The supply and exhaust fans shall run anytime the unit is commanded to run during the occupied period and the outside air damper end switch has proven the open damper position, unless shutdown on safeties. The fans shall have a user definable (adj.) minimum runtime to prevent short cycling. A current switch on each fan shall input the fan status to the controller. BAS alarms shall be provided as follows:
 1. Supply or Exhaust Fan Failure: Commanded on, but the status is off.
 2. Supply or Exhaust Fan in Hand: Commanded off, but the status is on.
 3. Supply or Exhaust Fan VFD Fault.
- D. Energy Wheel: The energy wheel shall be enabled for heating recovery mode whenever:
 1. The heating mode is active,
 2. AND the supply fan status is on,
 3. AND the exhaust fan status is on.

The energy wheel shall be disabled during economizer mode whenever:

4. Outside air temperature is greater than 50°F (adj.).

A current switch on the energy wheel shall input the wheel status to the controller. BAS alarms shall be provided as follows:

5. Energy Wheel Failure: Commanded on, but the status is off.
6. Energy Wheel in Hand: Commanded off, but the status is on.

Energy wheel defrost controls shall be either:

7. Factory mounted and wired including integral thermostat and timer. When the ambient temp drops below 35°F, the wheel shall stop every 30 minutes (adj.) for 2 minutes (adj.) to defrost/warm up in the exhaust airstream.
 8. Factory controls with wheel VFD speed control based on the outside air temperature and the pressure drop across the wheel. If the outdoor air temperature is below 5°F (adj.) and the differential pressure across the wheel is about 1.5" (adj.) frost control will enable and modulate the wheel VFD down to a slow rotational speed.
- E. Heating Valve and Freeze Protection Pump Control: Modulate the heating coil control valve to maintain the supply air heating setpoint of 70°F (adj.). Energize the freeze protection pump when the outside air temperature is less than 40°F (adj.), or when the heating coil control valve is commanded open. The heating shall be enabled whenever:
1. Outside air temperature is less than 68°F (adj.),
 2. AND the supply fan status is on.
- F. Energy Wheel Leaving Air Temperature: The controller shall monitor the energy wheel leaving air temperature (outside airstream). BAS alarms shall be provided as follows:
1. High Mixed Air Temp: If the energy wheel leaving air temperature is greater than 90°F (adj.).
 2. Low Mixed Air Temp: If the energy wheel leaving air temperature is less than 40°F (adj.).
- G. Outdoor Air Temperature: The controller shall monitor the outdoor air temperature.
- H. Supply Air Temperature: The controller shall monitor the supply air temperature. Alarms shall be provided as follows:
1. High Supply Air Temp: If the supply air temperature is greater than 90°F (adj.).
 2. Low Supply Air Temp: If the supply air temperature is less 50°F (adj.).
- I. Unoccupied: The supply and exhaust fans shall be normally de-energized. The outside air damper and exhaust air damper shall be normally closed and the re-circulation damper open. If the space temperature drops below 55°F (adj.), energize the supply fan and modulate the heating coil control valve to maintain the space temperature setpoint. Energize the freeze protection pump when the outside air temperature is less than 40°F (adj.), or when the heating coil control valve is commanded open. Unoccupied heating shall be enabled whenever:
1. Outside air temperature is less than 60°F (adj.).
- J. Safeties:
1. Supply and Return Air Smoke Detection (for units with airflow capacity of 2,000 CFM or greater): The unit shall shut down and generate an alarm upon receiving a supply or return air smoke detected status.
 2. Freeze Protection Pump Control: Energize the freeze protection pump when the outside air temperature is less than 40°F (adj.).
 3. Low Heating Coil Entering Air Temperature in Unoccupied Mode or Loss of Airflow: Modulate heating coil control valve to maintain unoccupied supply air

heating setpoint of 60°F (adj.) when the mixed air temperature is less than 50°F (adj.). The supply fan shall remain de-energized unless the space temperature falls below the unoccupied setpoint. The outside air damper shall remain closed. The same sequence shall apply when status is lost for the supply fan in occupied mode.

4. Freezestats: Disable the supply fan via a hard wired shutdown circuit and generate an alarm upon receiving a freezestat status. Open the heating coil control valve. Provide freezestats located on the leaving side of the heating coil. Alarm shall be manual reset.

K. Digital Inputs

1. Supply Fan Status
2. Exhaust Fan Status
3. Energy Wheel Status
4. Supply Duct Smoke Detector(s)
5. Return Duct Smoke Detector(s)
6. Freezestat
7. Unit Fault Alarm

L. Analog Inputs

1. Space Temperature: DOAS-1 – Boys Locker Room
2. Space Temperature: DOAS-2 – Girls Locker Room
3. Heating Coil Entering Air Temperature
4. Supply Air Temperature
5. Energy Wheel Leaving Air Temperature
6. Hot Water Return Temperature - DOAS

M. Digital Outputs

1. Supply Fan Command
2. Exhaust Fan Command
3. Energy Wheel Command
4. Freeze Protection Pump Command
5. Outdoor Air Damper
6. Recirculation Air Damper

N. Analog Outputs

1. Energy Wheel Speed
2. Heating Coil Valve

1.5 WESTBROOK PARK ELEMENTARY SCHOOL - VARIABLE AIR VOLUME (VAV) ROOFTOP AIR HANDLING UNITS WITH DX COOLING (RTU-1 AND RTU-2)

- A. General: The VAV air handling unit shall be controlled from a local DDC controller that shall perform temperature control, dehumidification control, pressure control, and time of day functions. The air handling unit shall operate on scheduled occupancy and to maintain setback / setup temperatures during scheduled unoccupied periods.

- B. Optimal Start: The unit shall start prior to scheduled occupancy based on the time necessary for the zones to reach their occupied setpoints. The start time shall automatically adjust based on changes in outside air temperature and zone temperatures.
1. VAV Box Optimal Start: The unit shall use an optimal start algorithm for morning start-up including hot water heating coil operation. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving individual zone comfort conditions by the start of the scheduled occupied period.
- C. Airflow Measurement:
1. Supply Airflow Measurement: The controller shall calculate the supply airflow using the measured airflow values for the associated variable air volume boxes.
- D. Supply Fan: The supply fan shall run anytime the unit is commanded to run, unless shutdown on safeties. The fan shall have a user definable (adj.) minimum runtime to prevent short cycling. A current switch on each fan shall input the fan status to the controller. BAS alarms shall be provided as follows:
1. Supply Fan Failure: Commanded on, but the status is off.
 2. Supply Fan in Hand: Commanded off, but the status is on.
 3. Supply Fan VFD Fault.
- E. Supply Air Duct Static Pressure Control: The controller shall measure duct static pressure and modulate the supply fan VFD speed to maintain the duct static pressure setpoint. The speed shall not drop below 30% (adj.). The static pressure setpoint shall be reset based on the zone requiring the most pressure; i.e., the setpoint is reset lower until one zone damper is 95% open (adj.). The initial duct static pressure setpoint shall be 1.00 in-wc (adj.). As cooling demand increases, the setpoint shall incrementally reset up to a maximum of 1.50 in-wc (adj.). As cooling demand decreases, the setpoint shall incrementally reset down to a minimum of 0.75 in-wc (adj.).
- BAS alarms shall be provided as follows:
1. High Supply Air Static Pressure: If the supply air static pressure is 25% (adj.) greater than setpoint.
 2. Low Supply Air Static Pressure: If the supply air static pressure is 25% (adj.) less than setpoint.
- F. Supply Air Temperature Setpoint - Optimized: The controller shall monitor the supply air temperature and shall maintain a supply air temperature setpoint reset based on zone cooling requirements. The supply air temperature setpoint shall be reset based on zone cooling requirements as follows:
1. The initial supply air temperature setpoint shall be 55°F (adj.).
 2. As cooling demand increases, the setpoint shall incrementally reset down to a minimum of 53°F (adj.).
 3. As cooling demand decreases, the setpoint shall incrementally reset up to a maximum of 62°F (adj.).
- G. DX Cooling: Energize and modulate DX cooling stages to maintain the supply air temperature setpoint. Compressor shall be variable capacity digital scroll type with modulating capacity control. Cooling shall be enabled whenever:

1. Outside air temperature is greater than 60°F (adj.),
 2. AND the economizer is disabled or fully open,
 3. AND the supply fan status is on.
- H. Economizer: The controller shall measure the mixed air temperature and modulate the economizer dampers in sequence to maintain a setpoint 3°F (adj.) less than the supply air temperature setpoint.
1. The economizer shall be enabled whenever:
 - a. Outside air temperature is less than 65°F (adj.),
 - b. AND the outside air enthalpy is less than 25 Btu/lb (adj.),
 - c. AND the outside air temperature is less than the return air temperature,
 - d. AND the outside air enthalpy is less than the return air enthalpy,
 - e. AND the supply fan status is on.
 2. The economizer shall close whenever:
 - a. Mixed air temperature drops from 48°F to 43°F (adj.),
 - b. OR on loss of supply fan status.
 3. The economizer shall be integrated with mechanical cooling and capable of providing partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load.
- I. Minimum Outside Air Ventilation: Whenever occupied, the outside air damper minimum position shall be reset to maintain the scheduled minimum outdoor airflow value. The minimum outdoor damper position for two (2) operating conditions shall be determined by the TAB Contractor corresponding with 100% system supply airflow and 60% system supply airflow.
1. Mixed air temperature low limit control shall override the minimum outdoor air damper command.
- J. Dehumidification: If the return air dew point temperature (based on BAS conversion of return air temperature and relative humidity readings) exceeds 58°F (adj.), enable dehumidification operation to lower the return air dew point temperature below 55°F (adj.). When the hot water system is enabled, lower the supply air temperature setpoint to 55°F (adj.). When the hot water system is not enabled, utilize hot gas reheat. Coordinate with the RTU / AHU manufacturer which compressor circuit(s) are connected to the hot gas reheat coil. Modulate the associated compressor circuit(s) to maintain the manufacturer's recommended evaporator coil suction pressure and saturation temperature. The suction pressure sensors shall be factory mounted by the RTU / AHU manufacturer. If recommended by the RTU / AHU manufacturer, modulate the associated compressor circuit(s) to maintain the evaporator coil discharge air temperature sensor setpoint (55°F, adj.) if evaporator coil suction pressure measurement is not provided by the manufacturer. Energize and modulate the hot gas reheat to maintain the supply air temperature setpoint. Dehumidification shall be enabled whenever:
1. Outside air temperature is greater than 60°F (adj.),
 2. AND the supply fan status is on,
 3. AND the cooling mode is not active.

- K. Mixed Air Temperature: The controller shall monitor the mixed air temperature and use as required for economizer control or preheating control. BAS alarms shall be provided as follows:
1. High Mixed Air Temp: If the mixed air temperature is greater than 90°F (adj.).
 2. Low Mixed Air Temp: If the mixed air temperature is less than 40°F (adj.).
- L. Space and Return Air Relative Humidity: The controller shall monitor the space and return air relative humidity and calculate the respective dew point temperature. The controller shall use the input values as required for economizer control or humidity control. BAS alarms shall be provided as follows:
1. High Space or Return Air Relative Humidity: If the space or return air relative humidity is greater than 68% (adj.).
 2. High Space or Return Air Dew Point Temp: If the space or return air dew point temperature is greater than 63°F (adj.).
- M. Return Air Temperature: The controller shall monitor the return air temperature and use as required for setpoint control or economizer control. BAS alarms shall be provided as follows:
1. High Return Air Temp: If the return air temperature is greater than 85°F (adj.).
 2. Low Return Air Temp: If the return air temperature is less than 55°F (adj.).
- N. Outdoor Air Temperature and Humidity (shared points): The controller shall monitor the outdoor air temperature and humidity and use as required for economizer control.
- O. Supply Air Temperature: The controller shall monitor the supply air temperature. BAS alarms shall be provided as follows:
1. High Supply Air Temp: If the supply air temperature is greater than setpoint by 10°F (adj.) for more than five minutes (adj.).
 2. Low Supply Air Temp: If the supply air temperature is less than 40°F (adj.).
- P. Unoccupied: The supply fan shall be de-energized. The outside air damper shall be closed and the return air damper open.
1. Heating Mode: If the space temperature for any associated zone falls below the unoccupied setpoint of 60°F (adj.) or the mixed air temperature falls below 45°F (adj.), the fan shall be energized and the outside air damper shall remain closed. As the respective zone temperature setpoint is satisfied and the mixed air temperature rises above 55°F (adj.), the fan shall be de-energized.
 2. Dehumidification Mode: If the space dew point temperature (based on BAS conversion of space temperature and relative humidity readings) exceeds 58°F (adj.), energize the supply fan and enable dehumidification operation (similar to occupied dehumidification sequence) to lower the space dew point temperature below 55°F (adj.). Unoccupied dehumidification shall be enabled whenever:
 - a. Outside air temperature is greater than 60°F (adj.),
 - b. AND space air temperature is greater than 70°F (adj.).
- Q. Safeties:

1. High Static Shutdown: Disable the supply fan via a hard wired shutdown circuit and generate an alarm upon receiving a high static shutdown signal from the discharge high limit static pressure switch. Alarm shall be manual reset.
2. Supply and Return Air Smoke Detection: Disable the supply fan via a hard wired shutdown circuit and generate an alarm upon receiving a supply or return air smoke detected status.
3. Supply Air Temperature Low Limit: If the supply air temperature drops below 38°F (adj.) disable the supply fan close the outdoor air damper.
4. Low Evaporator Suction Temperature: Disable the compressors and generate an alarm when the suction line temperature falls below 35°F.

R. Digital Inputs

1. Supply Fan Status
2. Discharge High Limit Static Pressure Switch
3. Supply Duct Smoke Detector
4. Return Duct Smoke Detector
5. Unit Fault Alarm

S. Analog Inputs

1. Space Relative Humidity: RTU-1 – Kindergarten 27
2. Space Relative Humidity: RTU-2 – Classroom 7
3. Return Air Temperature
4. Return Air Relative Humidity
5. Mixed Air Temperature
6. Supply Air Temperature
7. Duct Static Pressure
8. Evaporator Coil Suction Pressure or Evaporator Coil Discharge Air Temperature (as applicable)
9. Evaporator Suction Temperature
10. Compressor Amperage (each)

T. Digital Outputs

1. Supply Fan
2. Compressor Command

U. Analog Outputs

1. Supply Fan Speed
2. Hot Gas Reheat Control Valve
3. Economizer Dampers
4. Compressor Speed (variable capacity circuits)

1.6 WESTBROOK PARK ELEMENTARY SCHOOL - SINGLE ZONE ROOFTOP AIR HANDLING UNIT WITH DX COOLING AND HOT WATER HEATING COIL SERVING LIBRARY (RTU-3)

- A. General: The unit shall be controlled from a local DDC controller that shall perform temperature, dehumidification control, and ventilation functions. The unit shall operate

on scheduled occupancy and to maintain setback / setup temperatures during scheduled unoccupied periods.

- B. Optimal Start: The BAS shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period.
- C. Zone Sensor Adjustments:
 - 1. Zone setpoint shall be controlled only through the BAS and shall not be locally adjustable. The space temperature shall not be displayed at the zone sensor.
 - 2. Zone Unoccupied Override: The occupant shall be able to override the schedule and place the unit into an occupied mode for an adjustable period of time using the zone sensor timed override control. When the 'Manual On' button is depressed once, the Occupied LED shall turn on and the occupied heating / cooling setpoints shall take effect for 30 minutes (60 minutes when pressed twice, 90 minutes when pressed three times). At the expiration of this time, control of the unit shall automatically return to the schedule.
- D. Zone Temperature Setpoints:
 - 1. Occupied Mode: The unit shall maintain 75°F (adj.) cooling setpoint and 70°F (adj.) heating setpoint.
 - 2. Unoccupied Mode (night setback): The unit shall maintain 60°F (adj.) heating setpoint.
 - 3. BAS alarms shall be provided as follows:
 - a. High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
 - b. Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).
- E. Supply and Exhaust Fans: The supply fan shall run anytime the unit is commanded to run, unless shutdown on safeties. The exhaust fan shall run anytime the unit is commanded for economizer operation, unless shutdown on safeties. The fans shall have a user definable (adj.) minimum runtime to prevent short cycling. A current switch on each fan shall input the fan status to the controller. BAS alarms shall be provided as follows:
 - 1. Supply or Exhaust Fan Failure: Commanded on, but the status is off.
 - 2. Supply or Exhaust Fan in Hand: Commanded off, but the status is on.
 - 3. Supply Fan VFD Fault.
- F. Supply Fan Speed Control: At cooling or heating demands less than 50%, modulate the supply fan VFD speed to two-thirds of the full fan speed to comply with ASHRAE Standard 90.1.
- G. Exhaust Fan Speed Control: When in economizer operation, modulate the exhaust fan speed signal to track the economizer signal but not exceed the supply fan signal.
- H. DX Cooling: Energize and modulate DX cooling stages to maintain the space cooling temperature setpoint. One or more compressors shall be variable capacity digital scroll

type with modulating capacity control. One or more compressors shall be on / off control. Cooling shall be enabled whenever:

1. Outside air temperature is greater than 60°F (adj.),
 2. AND the economizer is disabled or fully open,
 3. AND the supply fan status is on,
 4. AND the heating is not active.
- I. Heating Valve and Freeze Protection Pump Control: Modulate the heating coil control valve to maintain the space heating temperature setpoint. Energize the freeze protection pump when the outside air temperature is less than 40°F (adj.), or when the heating coil control valve is commanded open. The heating shall be enabled whenever:
1. The economizer is disabled,
 2. AND the supply fan status is on.
- J. Economizer: Modulate the economizer dampers in sequence to maintain the space cooling setpoint based on the space temperature and the mixed air temperature.
1. The economizer shall be enabled whenever:
 - a. Outside air temperature is less than 65°F (adj.),
 - b. AND the outside air enthalpy is less than 25 Btu/lb (adj.),
 - c. AND the outside air temperature is less than the return air temperature,
 - d. AND the outside air enthalpy is less than the zone enthalpy,
 - e. AND the supply fan status is on.
 2. The economizer shall close whenever:
 - a. Mixed air temperature drops from 48°F to 43°F (adj.),
 - b. OR on loss of supply fan status.
 3. The economizer shall be integrated with mechanical cooling and capable of providing partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load.
- K. Minimum Outside Air Ventilation - Carbon Dioxide (CO₂) Control: The BAS shall measure the zone CO₂ level. The controller shall modulate the outside air damper open on rising CO₂ concentrations, overriding normal damper operation to maintain a CO₂ setpoint of 900 ppm (adj.). The outside air damper shall not open at a rate greater than 2 percent per minute (adj.). When the CO₂ setpoint is satisfied, reduce the outside air damper to 10% (adj.) minimum position. BAS alarms shall be provided as follows:
1. High Zone Carbon Dioxide Concentration: If the zone CO₂ concentration is greater than 1200 ppm (adj.).
- L. Dehumidification: If the space dew point temperature (based on BAS conversion of space temperature and relative humidity readings) exceeds 58°F (adj.), enable dehumidification operation to lower the space dew point temperature below 55°F (adj.). Coordinate with the RTU manufacturer which compressor circuit(s) are connected to the hot gas reheat coil. Modulate the associated compressor circuit(s) to maintain the manufacturer's recommended evaporator coil suction pressure and saturation temperature. The suction pressure sensors shall be factory mounted by the RTU manufacturer. If recommended by the RTU manufacturer, modulate the associated compressor circuit(s) to maintain the evaporator coil discharge air temperature sensor

setpoint (55°F, adj.) if evaporator coil suction pressure measurement is not provided by the manufacturer. Energize and modulate the hot gas reheat to maintain the space heating temperature setpoint. If after a time delay (20 minutes, adj.) the space dew point temperature remains above setpoint, enable additional compressor circuit(s). If the hot water system is enabled and the hot gas reheat is insufficient, modulate the heating coil control valve to maintain the space heating temperature setpoint. Dehumidification shall be enabled whenever:

1. Outside air temperature is greater than 60°F (adj.),
 2. AND space air temperature is greater than 70°F (adj.),
 3. AND the supply fan status is on,
 4. AND the heating mode is not active,
 5. AND the cooling mode is not active.
- M. Mixed Air Temperature: The controller shall monitor the mixed air temperature and use as required for economizer control. BAS alarms shall be provided as follows:
1. High Mixed Air Temp: If the mixed air temperature is greater than 90°F (adj.).
 2. Low Mixed Air Temp: If the mixed air temperature is less than 45°F (adj.).
- N. Zone Relative Humidity: The BAS shall measure the zone relative humidity and calculate the zone dew point air temperature. The controller shall use the input values as required for humidity control. BAS alarms shall be provided as follows:
1. High Zone Relative Humidity: If the zone relative humidity is greater than 68% (adj.).
 2. High Zone Dew Point Air Temp: If the zone dew point air temperature is greater than 63°F (adj.).
- O. Return Air Temperature: The controller shall monitor the return air temperature and use as required for setpoint control or economizer control. BAS alarms shall be provided as follows:
1. High Return Air Temp: If the return air temperature is greater than 90°F (adj.).
 2. Low Return Air Temp: If the return air temperature is less than 45°F (adj.).
- P. Outdoor Air Temperature and Humidity: The controller shall monitor the outdoor air temperature and dew point temperature.
- Q. Supply Air Temperature: The controller shall monitor the supply air temperature. Alarms shall be provided as follows:
1. High Supply Air Temp: If the supply air temperature is greater than 100°F (adj.).
 2. Low Supply Air Temp: If the supply air temperature is less 48°F (adj.).
- R. Unoccupied: The supply and exhaust fans shall be normally de-energized. The outside air damper shall be normally closed and the return air damper open.
1. Heating Mode: If the space temperature falls below the unoccupied setpoint of 55°F (adj.), the supply fan shall be energized and the outside air damper shall remain closed. Modulate the heating coil control valve to maintain the space heating temperature setpoint. As the space temperature setpoint is satisfied, the fan shall be de-energized.

2. Dehumidification Mode: If the space dew point temperature (based on BAS conversion of space temperature and relative humidity readings) exceeds 58°F (adj.), energize the supply fan and enable dehumidification operation (similar to occupied dehumidification sequence) to lower the space dew point temperature below 55°F (adj.). Unoccupied dehumidification shall be enabled whenever:
 - a. Outside air temperature is greater than 60°F (adj.),
 - b. AND space air temperature is greater than 70°F (adj.).

S. Safeties:

1. Supply and Return Air Smoke Detection: Disable the supply and exhaust fans via a hard wired shutdown circuit and generate an alarm upon receiving a supply or return air smoke detected status.
2. Freeze Protection Pump Control: Energize the freeze protection pump when the outside air temperature is less than 40°F (adj.).
3. Low Mixed Air Temperature in Unoccupied Mode or Loss of Airflow: Modulate heating coil control valve to maintain mixed air temperature setpoint of 50°F (adj.). The supply fan shall remain de-energized unless the space temperature falls below the unoccupied setpoint. The outside air damper shall remain closed. The same sequence shall apply when status is lost for the supply fan in occupied mode.
4. Freezestats: Disable the supply fan via a hard wired shutdown circuit and generate an alarm upon receiving a freezestat status. Open the heating coil control valve. Provide freezestats located on the leaving side of the heating coil. Alarm shall be manual reset.
5. Low Evaporator Suction Temperature: Disable the compressors and generate an alarm when the suction line temperature falls below 35°F.

T. Digital Inputs

1. Supply Fan Status
2. Exhaust Fan Status
3. Supply Duct Smoke Detector
4. Return Duct Smoke Detector
5. Zone Unoccupied Override
6. Freezestat
7. Unit Fault Alarm

U. Analog Inputs

1. Space Temperature and Relative Humidity
2. Space CO2 Concentration
3. Evaporator Coil Suction Pressure or Evaporator Coil Discharge Air Temperature (as applicable)
4. Evaporator Suction Temperature
5. Supply Air Temperature
6. Mixed Air Temperature
7. Return Air Temperature
8. Compressor Amperage (each)
9. Hot Water Return Temperature - RTU

V. Digital Outputs

1. Supply Fan Command
2. Exhaust Fan Command
3. Compressor Command (each)
4. Freeze Protection Pump

W. Analog Outputs

1. Supply Fan Speed
2. Exhaust Fan Speed
3. Compressor Speed (variable capacity circuit)
4. Energy Wheel Speed
5. Hot Gas Reheat Control Valve
6. Heating Coil Valve
7. Economizer Dampers

1.7 VARIABLE AIR VOLUME (VAV) BOXES WITH HOT WATER HEATING COIL

- A. The majority of VAV boxes are piped in series with Fin Tube Radiation. Provide one heating control valve piped as shown on drawings for series circuit configuration.
- B. General: The unit shall be controlled from a local DDC controller that shall perform temperature control and time of day functions. The unit shall operate on scheduled occupancy and to maintain setback / setup temperatures during scheduled unoccupied periods.
- C. Control Power: The control power (wiring, transformers, conduit, etc.) for each VAV box shall be provided by the controls contractor.
- D. VAV Box Optimal Start: The unit shall use an optimal start algorithm for morning start-up including hot water heating coil operation. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of the scheduled occupied period.
- E. Zone Sensor Adjustments:
 1. Zone Setpoint Adjust: The occupant shall be able to adjust the zone temperature heating and cooling setpoints with the 'warmer / cooler' slide adjust at the zone sensor. The range of the setpoint adjustment shall be user definable for each zone (+/- 2°F, adj.). The space temperature shall not be displayed at the zone sensor.
 2. Zone Unoccupied Override: The occupant shall be able to override the schedule and place the unit into an occupied mode for an adjustable period of time using the zone sensor timed override control. When the 'Manual On' button is depressed, the Occupied LED shall turn on and the occupied heating / cooling setpoints shall take effect for a user definable duration (60 minutes, adj.). At the expiration of this time, control of the unit shall automatically return to the schedule.

- F. Zone Temperature Setpoints:
1. Occupied Mode: The unit shall maintain 75°F (adj.) cooling setpoint and 70°F (adj.) heating setpoint.
 2. Unoccupied Mode (night setup / setback): The unit shall maintain 85°F (adj.) cooling setpoint and 60°F (adj.) heating setpoint.
 3. Alarms shall be provided as follows:
 - a. High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
 - b. Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).
- G. Supply Airflow Measurement: The controller shall directly measure the unit supply airflow.
- H. Air Valve and Heating Coil Control - The controller shall employ a “dual maximum” control logic as follows:
1. When the zone temperature is greater than its cooling setpoint, the zone damper shall modulate between the minimum cooling airflow setpoint (adj.) and the maximum cooling airflow setpoint (adj.) until the zone is satisfied.
 2. When the zone temperature is in the deadband range between cooling and heating setpoints, maintain airflow at the minimum cooling airflow setpoint.
 3. When the zone temperature is below the heating setpoint, the zone damper shall modulate to the minimum heating airflow setpoint (adj.). Modulate the heating coil control valve to maintain the zone temperature heating setpoint, but not above the supply air temperature maximum setpoint of 95°F (adj.). If the zone temperature remains below the heating setpoint, the zone damper shall modulate between the minimum heating airflow setpoint (adj.) and the maximum heating airflow setpoint (adj.) and the heating coil control valve shall modulate to maintain a supply air temperature setpoint of 95°F (adj.) until the zone is satisfied.
 4. VAV boxes with Fin Tube Radiation Piped in Series: Provide one heating control valve piped as shown on drawings for series circuit configuration.
- I. Supply Air Temperature: The controller shall monitor the supply air temperature. Alarms shall be provided as follows:
1. High Supply Air Temp: If the supply air temperature is greater than 110°F (adj.).
 2. Low Supply Air Temp: If the supply air temperature is less than 45°F (adj.).
- J. Safeties:
1. Low Supply Air Temperature in Unoccupied Mode or Loss of Airflow: Modulate heating coil control valve to maintain supply air temperature setpoint of 50°F (adj.). The associated RTU supply fan shall remain de-energized unless the space temperature for any associated zone falls below the unoccupied setpoint. The associated RTU outside air damper shall remain closed. The same sequence shall apply when status is lost for the supply fan in occupied mode.
 2. Supply Air Temperature Low Limit: If the supply air temperature drops below 38°F (adj.) disable the associated RTU supply fan. Open the heating coil control valve.

- K. Digital Inputs
 - 1. Zone Unoccupied Override
- L. Analog Inputs
 - 1. Zone Temperature
 - 2. Supply Air Temperature
 - 3. Supply Airflow
- M. Analog Outputs
 - 1. Air Valve
 - 2. Heating Coil

1.8 CABINET UNIT HEATERS (HYDRONIC)

- A. General: The unit shall be controlled from a local DDC controller that shall perform temperature control and time of day functions. The unit shall operate on scheduled occupancy and to maintain setback temperatures during scheduled unoccupied periods.
- B. Zone Temperature Setpoints:
 - 1. Occupied Mode: The unit shall maintain 65°F (adj.) heating setpoint.
 - 2. Unoccupied Mode (night setback): The unit shall maintain 55°F (adj.) heating setpoint.
 - 3. Low Zone Temp Alarm shall be provided as follows: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).
- C. Heating: Cycle the fan and command the heating valve to maintain the heating setpoint.
- D. Unit Lockout:
 - 1. All cabinet heater fans shall be disabled and heating valves closed when the outside air temperature is above a user definable setpoint (60°F, adj.).
- E. Digital Inputs
 - 1. Fan Status
- F. Analog Inputs
 - 1. Zone Temperature
- G. Digital Outputs
 - 1. Supply Fan
 - 2. Heating Coil Valve

1.9 HOT WATER DUCT HEATING COILS

- A. General: The unit shall be controlled from a local DDC controller that shall perform temperature control and time of day functions. The unit shall operate on scheduled

occupancy and to maintain setback temperatures during scheduled unoccupied periods.

B. Zone Temperature Setpoints:

1. Occupied Mode: The unit shall maintain 70°F (adj.) heating setpoint.
2. Unoccupied Mode (night setback): The unit shall maintain 55°F (adj.) heating setpoint.
3. Low Zone Temp Alarm shall be provided as follows: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).

C. Heating: Modulate the heating valve to maintain the heating setpoint.

D. Analog Inputs

1. Zone Temperature

E. Analog Outputs

1. Heating Coil Valve

1.10 CONVECTORS (HYDRONIC)

A. General: The unit shall be controlled from a local DDC controller that shall perform temperature control and time of day functions. The unit shall operate on scheduled occupancy and to maintain setback temperatures during scheduled unoccupied periods.

B. Zone Temperature Setpoints:

1. Occupied Mode: The unit shall maintain 65°F (adj.) heating setpoint.
2. Unoccupied Mode (night setback): The unit shall maintain 55°F (adj.) heating setpoint.
3. Low Zone Temp Alarm shall be provided as follows: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).

C. Heating: Command the heating valve to maintain the heating setpoint.

D. Analog Inputs

1. Zone Temperature

E. Digital Outputs

1. Heating Coil Valve

1.11 HIGH SCHOOL SOUND BOOTH - SPLIT SYSTEM AIR CONDITIONING UNITS

A. General: The unit shall be controlled from a unitary controller provided by the equipment manufacturer. The DDC system shall independently monitor room temperature.

B. Alarms: BAS alarms shall be provided for high and low zone temperature.

C. Analog Inputs

1. Zone Temperature

1.12 EXHAUST FANS – SCHEDULED

- A. General: The unit shall be controlled from a local DDC controller that shall perform time of day functions.
- B. Fan: The fan shall have a user definable (adj.) minimum runtime.
- C. Fan Status: The controller shall monitor the fan status.
- D. Alarms shall be provided as follows:
 - 1. Exhaust Fan Failure: Commanded on, but the status is off.
 - 2. Exhaust Fan in Hand: Commanded off, but the status is on.
 - 3. Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).
- E. Digital Inputs
 - 1. Fan Status
- F. Digital Outputs
 - 1. Exhaust Fan

END OF SECTION 230940

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes piping, special-duty valves, and hydronic specialties for hot-water heating and condensate drain piping.
- B. See Division 23 Section "Basic Mechanical Materials and Methods" for general piping materials and installation requirements.
- C. See Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.

1.2 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to the ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- 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 the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Copper Tube and Fittings:
 - 1. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
 - 2. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
 - 3. DWV Copper Tubing: ASTM B 306, Type DWV.
 - 4. Wrought-Copper Fittings: ASME B16.22.
 - 5. Wrought-Copper Unions: ASME B16.22.
 - 6. Solder Filler Metals: ASTM B 32, 95-5 tin antimony.
- B. Copper or Bronze Pressure-Seal Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Mueller Industries, Inc.
 - b. Nibco Inc.
 - c. 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.

C. Steel Pipe and Fittings:

1. Steel Pipe, NPS 2 and Smaller: ASTM A 53, Type S (seamless), Grade A, Schedule 40, black steel, plain ends.
2. Steel Pipe, NPS 2-1/2 and larger: ASTM A 53, Type E (electric-resistance welded), Grade A, Schedule 40, black steel, plain ends.
3. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53, Schedule 40, black steel; seamless for NPS 2 and smaller and electric-resistance welded for NPS 2-1/2 and larger.
4. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250.
5. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.
6. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300.
7. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced.
8. Grooved Mechanical-Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47, Grade 32510 malleable iron; ASTM A 53, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders designed to accept grooved end couplings.
9. Grooved Mechanical-Joint Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
10. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.

2.2 VALVES

- A. General-Duty Valves: Check, ball, and butterfly valves are specified in Division 23 Section "Valves."
- B. Calibrated Balancing Valves, NPS 2 and Smaller: Bronze body, ball type, 125-psig working pressure, 250 deg F maximum operating temperature, and having threaded ends. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set position.
- C. Calibrated Balancing Valves, NPS 2-1/2 and Larger: Cast-iron or steel body, ball type, 125-psig working pressure, 250 deg F maximum operating temperature, and having flanged or grooved connections. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set position.
- D. Pressure-Reducing Valves: Diaphragm-operated, bronze or brass body with low inlet pressure check valve, inlet strainer removable without system shutdown, and noncorrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory set at operating pressure and have capability for field adjustment.

- E. Safety Valves: Diaphragm-operated, bronze or brass body with brass and rubber, wetted, internal working parts; shall suit system pressure and heat capacity and shall comply with the ASME Boiler and Pressure Vessel Code, Section IV.
- F. Reduced-Pressure-Principle Backflow Prevention Assemblies: ASSE 1013 and AWWA C511, suitable for continuous pressure application; 175-psig working pressure. Include two independently operating, spring-loaded check valves with a spring-loaded pressure relief valve in between; quarter-turn, full port, resilient seated bronze ball valves and ball type test cocks on inlet and outlet, and strainer on inlet. NPT female connections and bronze body.

2.3 HYDRONIC SPECIALTIES

- A. Manual Air Vent: Bronze body and nonferrous internal parts; 150-psig working pressure; 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; with NPS 1/8 discharge connection and NPS 1/2 inlet connection.
- B. Automatic Air Vent: Designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150-psig working pressure; 240 deg F operating temperature; with NPS 1/4 discharge connection and NPS 1/2 inlet connection.
- C. Air, Dirt and Hydraulic Separators:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Caleffi
 - b. Spirotherm
 - c. Wessels Company
 - 2. Standard velocity, coalescing type air, dirt and hydraulic separator to remove entrained air and particulate from the system water. Separator shall have two separate circuits to function as a hydraulic separator in a low loss header where indicated on the drawings. Unit shall have integral brass, float-operated venting mechanism with Viton seal. Coalescing media shall be Type 304 stainless steel. All dirt particles of size 30 microns and larger shall be removed within 100 passes. Separators shall be factory tested with taps fabricated and labeled according to the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1. Rated for 150-psig working pressure and 240 deg F maximum operating temperature.
- D. Y-Pattern Strainers: 125-psig working pressure; cast-iron body (ASTM A 126, Class B), flanged ends for NPS 2-1/2 and larger, threaded connections for NPS 2 and smaller, bolted cover, perforated stainless-steel basket, and bottom drain connection.
- E. Flexible Connectors: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150-psig minimum working pressure and 250 deg F maximum operating temperature. Connectors shall have flanged- or threaded-end connections to match equipment connected and shall be capable of 3/4-inch misalignment.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot Water:

1. Type L drawn-temper copper tubing with soldered joints or pressure seal fittings (NPS 2 and smaller).
2. Schedule 40 steel pipe with threaded, welded, or grooved mechanical joints.

B. Condensate Drain Lines:

1. Indoors: Type L drawn-temper copper tubing with soldered joints or Schedule 40 CPVC piping.
2. Outdoors: Type L drawn-temper copper tubing or Schedule 40 galvanized steel piping.

3.2 VALVE APPLICATIONS

A. Unless otherwise indicated, use the following general-duty valve types for applications indicated:

1. Shutoff Duty: ball and butterfly valves.
2. Throttling Duty: ball valves.
3. Install shutoff duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.
4. Install check valves at each pump discharge and elsewhere as required to control flow direction.

B. Unless otherwise indicated, use the following special-duty valve types for applications indicated:

1. Install calibrated balancing valves in the return water line of each heating or cooling element and elsewhere as required to facilitate system balancing.
2. Install safety valves on hot-water generators and elsewhere as required by the ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to floor. Comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for installation requirements.
3. Install pressure-reducing valves on hot-water generators and elsewhere as required to regulate system pressure.

3.3 PIPING INSTALLATIONS

- #### A.
- 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.

- B. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- C. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- D. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.
- E. Install strainers on supply 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.
- F. Anchor piping for proper direction of expansion and contraction.

3.4 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports." Comply with requirements below for maximum spacing of supports. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
 - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
 - 5. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
 - a. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
 - b. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
 - c. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 - d. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 - e. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
 - f. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
 - g. NPS 4 and 6: Maximum span, 14 feet; minimum rod size, 1/2 inch.
 - h. NPS 8: Maximum span, 14 feet; minimum rod size, 5/8 inch.
 - 6. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
 - a. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - b. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - c. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - d. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - e. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 - f. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.

7. Elastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
8. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

- A. Refer to Division 23 Section "Basic Mechanical Materials and Methods " for joint construction requirements for soldered joints in copper tubing; threaded, welded, and flanged joints in steel piping.
- B. Comply with manufacturer's written installation instructions for manufactured pressure seal fittings and grooved mechanical-joint couplings.

3.6 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.
 1. Install automatic air vents in mechanical equipment rooms only at high points of system piping, at heat-transfer coils, and elsewhere as required for system air venting.
 2. Install in-line air separators in pump suction lines. Install piping to compression tank with a 2 percent upward slope toward tank. Install drain valve on units NPS 2 and larger.
 3. Install combination air separator and strainer in pump suction lines. Install piping to compression tank with a 2 percent upward slope toward tank. Install blowdown piping with gate valve; extend to nearest drain.
 4. Install bypass chemical feeders in each hydronic system adjacent building heating and chilled water pumps, in upright position with top of funnel not more than 48 inches above floor. Install feeder in bypass line, off main, using globe valves on each side of feeder and in the main between bypass connections. Pipe drain, with ball valve, to nearest equipment drain.
 5. Install and anchor expansion tanks on floor or on welded steel mounting frame.

3.7 TERMINAL EQUIPMENT CONNECTIONS

- A. Size for supply and return piping connections shall be same as for equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install ports for pressure and temperature gages at coil inlet connections.

3.8 FIELD QUALITY CONTROL

- A. Prepare hydronic piping and perform testing according to ASME B31.9. All testing and inspections shall be coordinated with the Construction Manager. Prepare written report of testing.

3.9 ADJUSTING

- A. Mark calibrated nameplates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.
- B. Perform these adjustments before operating the system:
 - 1. Open valves to fully open position. Close coil bypass valves.
 - 2. Check pump for proper direction of rotation.
 - 3. Set automatic fill valves for required system pressure.
 - 4. Check 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. Check operation of automatic bypass valves.
 - 7. Check and set operating temperatures of boilers, chillers, and heat exchangers to design requirements.
 - 8. Lubricate motors and bearings.

3.10 CLEANING

- A. Flush hydronic piping systems with clean water. All chemicals used to flush the system shall be properly removed from the site by the contractor. Do not flush wastes into the sanitary sewer system. Remove and clean or replace strainer screens. After cleaning and flushing hydronic piping systems, but before balancing, remove disposable fine-mesh strainers in pump suction diffusers.

END OF SECTION 232113

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following categories of hydronic pumps for hydronic systems:
 - 1. In-line circulators.
- B. Refer to Section 230512 "Variable Frequency Motor Drives".

1.2 SUBMITTALS

- A. Product Data: Include certified performance curves and rated capacities; shipping, installed, and operating weights; furnished specialties; final impeller dimensions; and accessories for each type of product indicated. Indicate pump's operating point on curves.
- B. Shop Drawings: Show pump layout and connections. Include Setting Drawings with templates for installing foundation and anchor bolts and other anchorages.
 - 1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.
- C. Maintenance Data: For pumps to include in maintenance manuals.

1.3 QUALITY ASSURANCE

- A. UL Compliance: Fabricate and label pumps to comply with UL 778, "Motor-Operated Water Pumps," for construction requirements.
- B. Product Options: Drawings indicate size, profiles, connections, and dimensional requirements of pumps and are based on the specific types indicated.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
- B. Store pumps in dry location.
- C. Retain protective covers for flanges and protective coatings during storage.

- D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
- E. Comply with pump manufacturer's written rigging instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. In-Line Circulators:
 - a. Bell & Gossett (Basis of Design)
 - b. Armstrong
 - c. Aurora Pump
 - d. Patterson Pump Co.
 - e. Wilo

2.2 GENERAL PUMP REQUIREMENTS

- A. Pump Units: Factory assembled and tested.
- B. Motors:
 - 1. Include built-in, thermal-overload protection and grease-lubricated ball bearings. Select each motor to be nonoverloading over full range of pump performance curve.
 - 2. ODP Premium Efficient
 - 3. Factory Installed Aegis Grounding Ring for Inverter / VFD Protection
- C. Motors Indicated to Be Energy Efficient: Minimum efficiency as indicated according to IEEE 112, Test Method B. Include motors with higher efficiency than "average standard industry motors" according to IEEE 112, Test Method B, if efficiency is not indicated.
- D. Motors shall be inverter-duty type designed per NEMA Standard MG1, Section IV, and Part 31.

2.3 IN-LINE CIRCULATORS

- A. Description: Horizontal or vertical, in-line, centrifugal, close-coupled single-stage design; rated for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.
 - 1. Pumps shall be of a horizontal, permanently lubricated type, specifically designed for quiet operation. The pump shall be single stage, vertical split case design, in

- cast iron bronze fitted construction. The pump internals shall be capable of being services without disturbing piping connections.
2. Pumps shall be composed of three separable components a motor, bearing assembly, and pump end (wet end). The motor shaft shall be connected to the pump shaft via a replaceable flexible coupler.
 3. Pumps shall have a solid SAE1144 steel shaft supported by two sealed ball bearings. A non-ferrous shaft sleeve shall be employed to completely cover the wetted area under the seal.
 4. Pumps shall be equipped with an internally-flushed mechanical seal assembly. Seal assembly shall be the unitized type with stainless steel drive tabs, EPR bellows and seat gasket, stainless steel spring, and be of a carbon silicon-carbide design with the carbon face rotating against a stationary silicon-carbide face.
 5. Bearing assembly shaft shall connect to a cast bronze impeller. Impeller shall be hydraulically and dynamically balanced, keyed to the shaft and secured by a locking capscrew or nut.
 6. A flexible type coupling shall be employed between the pump and motor.
 7. Pump should be designed to allow for true back pull-out access to the pump's working components for ease of maintenance.
 8. Pump volute shall be of cast iron design. The connection style shall be flanged. Volute shall include gauge ports at nozzles, and vent and drain ports.
 9. To ensure alignment the motor shall be mounted to the bearing assembly via a bolted motor bracket assembly, and a rubber motor mount shall be used to assist in aligning the motor shaft with the pump shaft.
 10. Motors shall meet scheduled horsepower, speed, voltage, and enclosure design. Motors through 1 HP shall be resilient mounted. Motors shall have permanently lubricated ball bearings and must be completely maintenance free. Motors shall be non-overloading at any point on the pump curve and shall meet NEMA specifications.
 11. Pump shall be of a maintainable design and for ease of maintenance should use machine fit parts and not press fit components.

2.4 PUMP SPECIALTY FITTINGS

- A. Suction Diffuser: Angle or straight pattern, 175-psig (1200-kPa) pressure rating, cast-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory- or field-fabricated support.
- B. Triple-Duty Valve: Angle or straight pattern, 175-psig (1200-kPa) pressure rating, cast-iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation.
 - 1. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
 - 2. Examine foundations for suitable conditions where pumps are to be installed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

- A. Install pumps according to manufacturer's written instructions.
 - 1. Install pumps according to HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."
- B. Install pumps to provide access for periodic maintenance, including removing motors, impellers, couplings, and accessories.
- C. Support pumps and piping separately so piping is not supported by pumps.
- D. Suspend in-line pumps using continuous-thread hanger rod and vibration-isolation hangers, floor mounted or wall mounted pump support frames.

3.3 ALIGNMENT

- A. Align pump and motor shafts and piping connections after setting them on foundations, after grout has been set and foundation bolts have been tightened, and after piping connections have been made.
- B. Comply with pump and coupling manufacturers' written instructions.
- C. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."
- D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.

- C. Connect piping to pumps. Install valves that are the same size as piping connected to pumps.
- D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- E. Install check valve and throttling valve on discharge side of in-line circulators.
- F. Install pressure gages on pump suction and discharge. Install at integral pressure-gage tapings where provided.
- G. Install electrical connections for power, controls, and devices.
- H. Electrical power and control wiring and connections are specified in Division 26 Sections.
- I. Ground equipment.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 EQUIPMENT START UP

- A. Coordinate all testing and inspections with the SitelogIQ Energy Services.
- B. Verify that pumps are installed and connected according to the Contract Documents.
- C. Verify that electrical wiring installation complies with manufacturer's written instructions and the Contract Documents.
- D. Perform the following preventive maintenance operations and checks before starting:
 - 1. Lubricate bearings.
 - 2. Remove grease-lubricated bearing covers, flush bearings with kerosene, and clean thoroughly. Fill with new lubricant according to manufacturer's written instructions.
 - 3. Disconnect coupling and check motor for proper rotation that matches direction marked on pump casing.
 - 4. Verify that pumps are free to rotate by hand and that pumps for handling hot liquids are free to rotate with pumps hot and cold. Do not operate pumps if they are bound or drag, until cause of trouble is determined and corrected.
 - 5. Check suction piping connections for tightness to avoid drawing air into pumps.
 - 6. Clean strainers.
 - 7. Verify that pump controls are correct for required application.
- E. Starting procedure for pumps with shutoff power not exceeding safe motor power is as follows:
 - 1. Prime pumps by opening suction valves and closing drains, and prepare pumps for operation.

2. Open cooling water-supply valves in cooling water supply to bearings, where applicable.
 3. Open cooling water-supply valves if stuffing boxes are water cooled.
 4. Open sealing liquid-supply valves if pumps are so fitted.
 5. Open warm-up valves of pumps handling hot liquids if pumps are not normally kept at operating temperature.
 6. Open circulating line valves if pumps should not be operated against dead shutoff.
 7. Start motors.
 8. Open discharge valves slowly.
 9. Check general mechanical operation of pumps and motors.
- F. When pumps are to be started against closed check valves with discharge shutoff valves open, steps are the same, except open discharge valves before starting motors.
- G. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for detailed requirements for testing, adjusting, and balancing hydronic systems.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps as specified below:
1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining pumps.
 2. Review data in maintenance manuals.

END OF SECTION 232123

SECTION 23313 – METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes metal ducts and fittings for supply and exhaust air-distribution systems.
- B. See Division 23 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
 - 1. Material gages and finishes.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Detail location of all duct access doors
 - 2. Drawings indicating clearances, routing, support, duct isolation joints and fittings.

1.3 QUALITY ASSURANCE

- A. NFPA Compliance:
 - 1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
 - 2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Fire-Test-Response Characteristics: Provide products with flame-spread and smoke-developed indices of 25 and 50, respectively, according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

- A. Comply with SMACNA's current "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. All ductwork

shall be a minimum of 24-gauge. Provide ductwork of heavier gauge where required by current SMACNA Standards.

- B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 (Z275) coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
- C. Stainless Steel: ASTM A 480/A 480M, Type 316, sheet form with No.4 finish for surfaces of ducts exposed to view; and Type 304, sheet form with No.1 finish for concealed ducts.
- D. Aluminum Sheets: ASTM B 209 (ASTM B 209M), Alloy 3003, Temper H14, sheet form with standard, one-side bright finish for ducts exposed to view and with mill finish for concealed ducts.
- E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.
- F. 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 SEALANT MATERIALS

- A. Solvent-Based Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant formulated with a minimum of 75 percent solids.
- B. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.
- C. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.3 HANGERS AND SUPPORTS

- A. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- B. Hanger Materials: Galvanized sheet steel or threaded steel rod.
 - 1. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.
- C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- D. Trapeze and Riser Supports: Galvanized-steel shapes and plates complying with ASTM A 36/A 36M.

2.4 RECTANGULAR DUCT FABRICATION

- A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
 1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
 2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- B. Fabricate range hood exhaust ducts with a minimum of 16-gauge, carbon-steel sheet for concealed ducts. Weld seams and joints. Comply with NFPA 96.
- C. Fabricate dishwasher hood exhaust ducts with a minimum of 18-gauge stainless steel. Weld seams and joints.
- D. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.
- E. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details.
 1. Duct Size: Maximum 30 inches wide and up to 2-inch wg pressure class.
 2. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant.
- F. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of nonbraced panel area unless ducts are lined.

2.5 ROUND AND FLAT-OVAL DUCT FABRICATION

- A. General: Diameter as applied to flat-oval ducts in this Article is the diameter of the size of round duct that has a circumference equal to perimeter of a given size of flat-oval duct.

- B. Round Ducts: Fabricate ducts of galvanized steel according to SMACNA's current "HVAC Duct Construction Standards--Metal and Flexible."
- C. Double-Wall (Insulated) Ducts: Fabricate double-wall (insulated) ducts with an outer shell and an inner metal liner. Dimensions indicated on internally insulated ducts are inside dimensions.
 - 1. Thermal Conductivity (k-value): 0.13 Btu / hr-ft²-deg-F at 75 deg-F mean temperature for 1-inch thick insulation.
 - 2. Outer shell: Base outer-shell metal thickness on actual outer-shell dimensions. Fabricate outer-shell lengths 2 inches (50 mm) longer than inner shell and insulation, and in metal thickness specified for single-wall duct.
 - 3. Insulation: 1-inch thick, 1.0 lb/ft³ insulation coated with an EPA registered antimicrobial product. Terminate insulation where internally insulated duct connects to single-wall duct or uninsulated components. Terminate insulation and reduce outer duct diameter to inner liner diameter.
 - 4. Perforated Inner Liner: Fabricate round, flat-oval, and rectangular inner liners with sheet metal having 3/32-inch diameter perforations, with an overall open area of 23 percent. Use 0.019 inch thick sheet metal with single-rib spiral seam construction.
- D. Maintain concentricity of liner to outer shell by mechanical means. Retain insulation from dislocation by mechanical means.

2.6 DUCT LINER

- A. Fibrous-Glass Duct Liner with Reinforced Coating System: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 - 1. Basis of Design: Johns Manville Linacoustic RC-HP
 - 2. Thermal Conductivity (k-value): 0.23 Btu / hr-ft²-deg-F at 75 deg-F mean temperature for 1-inch thick insulation.
 - 3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 - 4. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
 - 5. Product shall be UL GREENGUARD GOLD Certified including coating and adhesive.
 - 6. Minimum Sound Absorption Coefficients based on testing in accordance with ASTM C 423 and ASTM E 795:
 - a. 0.24 at 250 Hz
 - b. 0.69 at 500 Hz
 - c. 0.96 at 1000 Hz
 - d. 1.05 at 2000 Hz
- B. Insulation Pins and Washers

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized steel or aluminum; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."
1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
 2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
 3. Butt transverse joints without gaps, and coat joint with adhesive.
 4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
 5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
 6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
 7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
 8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - a. Fan discharges.
 - b. Intervals of lined duct preceding unlined duct.
 - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
 9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
 - a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
 10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

PART 3 - EXECUTION

3.1 DUCT APPLICATIONS

- A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:
 - 1. Supply Ducts (Positive Pressure): 2-inch wg.
 - 2. Exhaust Ducts (Negative Pressure): 2-inch wg.

3.2 DUCT INSTALLATION

- A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards-Metal and Flexible," unless otherwise indicated.
- B. Install ducts with fewest possible joints.
- C. Install fabricated fittings for changes in directions, size, and shape and for connections.
- D. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.
- E. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
- F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness. Coordinate wall openings to ensure duct insulation is continuous through penetrations unless penetrations include a fire or smoke damper.
- H. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.
- I. Coordinate layout with structure, suspended ceiling, lighting layouts, and similar finished work.
- J. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
- K. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- L. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.

- M. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Fire and smoke dampers are specified in Division 23 Section "Duct Accessories." Firestopping materials and installation methods are specified in Division 7 Section "Through-Penetration Firestop Systems."
- N. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction."

3.3 SEAM AND JOINT SEALING

- A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.
 - 1. For 3-inch wg pressure class, seal transverse joints and seams.
 - 2. For pressure classes lower than 2-inch wg, seal transverse joints.
- B. Seal ducts before external insulation is applied.

3.4 HANGING AND SUPPORTING

- A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.
- B. Support vertical ducts at maximum intervals of 12 feet and at each floor.
- C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
- D. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors according to Division 23 Section "Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards-Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 FIELD QUALITY CONTROL

- A. Maximum Allowable Leakage: Comply with requirements for Leakage Classification 4 for round and flat-oval ducts, and Leakage Classification 8 for rectangular ducts.

END OF SECTION 233113

SECTION 233600 - AIR TERMINALS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes single-duct air terminals.

1.2 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each model indicated. Include a schedule showing drawing designation, room location, number furnished, model number, size, and accessories furnished.
- B. Shop Drawings: Include plans, elevations, sections, and details; details of installation; and attachments to other Work.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. NFPA Compliance: Install air terminals according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- C. Comply with NFPA 70 for electrical components and installation.
- D. Certification Requirements: Certify air terminals according to ARI 880.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following manufacturers:
 - 1. Anemostat
 - 2. Envirotec
 - 3. Titus
 - 4. Nailor
 - 5. Price Industries

2.2 SINGLE-DUCT AIR TERMINALS

- A. Configuration: Volume-damper assembly inside unit casing. Locate control components inside protective metal shroud.
- B. Casings: Minimum 20-gauge galvanized steel.
- C. Casing Lining: Minimum of 1-inch-thick, neoprene- or vinyl-coated, fibrous-glass insulation; 3-lb/cu. ft. density, complying with NFPA 90A requirements and UL 181 erosion requirements. Insulation shall be sealed from the airstream with a solid 22-gauge galvanized steel liner. Terminals shall be designed for use with primary airflow temperatures as low as 40 deg-F.
- D. Plenum Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
- E. Plenum Air Outlets: S-slip and drive connections.
- F. Access: Removable panels to permit access to dampers and other parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
- G. Volume Damper: Construct of galvanized steel with peripheral gasket and self-lubricating bearings.
 - 1. Maximum Damper Leakage: 2 percent of nominal airflow at 3-inch wg inlet static pressure.
 - 2. Damper Position: Normally open.
- H. Hot-Water Heating Coil: 1/2-inch copper tube, mechanically expanded into aluminum-plate fins; leak tested underwater to 200 psig; and factory installed.
- I. Controls: Factory mount and wire controllers and actuators supplied by the BAS Manufacturer. Power Requirements: 24 -V ac.

2.3 SOURCE QUALITY CONTROL

- A. Testing Requirements: Test and rate air terminals according to ARI 880, "Industry Standard for Air Terminals."
- B. Identification: Label each air terminal with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install air terminals with sufficient clearance for normal service and maintenance.
- B. Connect ducts to air terminals.
- C. Install piping adjacent to air terminals to allow service and maintenance.

- D. Connect heating coils to supply with ball valve, strainer, control valve, PT-plug and union or flange; and to return with ball valve, balancing valve, PT-plug and union or flange. Refer to detail on drawings.
- E. Electrical: Comply with applicable requirements in Division 26 Sections.

3.2 FIELD QUALITY CONTROL

- A. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Verify unit casing and connecting supply air ductwork does not have any condensation during operation at design supply air temperature (55 deg-F) and ambient temperature conditions between 66 and 68 deg-F wet bulb. Where condensation occurs, insulate air terminal casing and ductwork connections and seal associated vapor barrier to eliminate condensation.

END OF SECTION 233600

SECTION 233713 - DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Volume dampers.
 - 2. Fire dampers.
 - 3. Turning vanes.
 - 4. Duct-mounting access doors.
 - 5. Flexible connectors.
 - 6. Flexible ducts.
 - 7. Duct accessory hardware.

1.2 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 - PRODUCTS

2.1 SHEET METAL 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.
- B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
- C. Stainless Steel: ASTM A 480/A 480M.
- D. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum: ASTM B 221, alloy 6063, temper T6.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- G. 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 VOLUME DAMPERS

- A. Manufacturers:
 - 1. Air Balance, Inc.
 - 2. McGill AirFlow Corporation.
 - 3. METALAIRE, Inc.
 - 4. PennBerry.
 - 5. Ruskin Company.
- B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.
- C. Standard Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.
 - 1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
 - 2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized sheet steel.
 - 3. Blade Axles: Galvanized steel.
 - 4. Bearings: Oil-impregnated bronze.
 - 5. Tie Bars and Brackets: Galvanized steel.
- D. Jackshaft: 1-inch- diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
 - 1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.
- E. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.3 FIRE DAMPERS

- A. Manufacturers:
 - 1. Greenheck.
 - 2. PennBerry.
 - 3. Ruskin Company.
- B. Fire dampers shall be labeled according to UL 555.
- C. Fire Rating: 1-1/2 hours.

- D. Frame: Curtain type with blades outside 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. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies 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. Fusible Links: Replaceable, 165 deg F rated.

2.4 TURNING VANES

- A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.
- B. Manufactured Turning Vanes: Fabricate 1-1/2-inch- wide, single -vane, curved blades of galvanized sheet steel set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.
 - 1. Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Duro Dyne Corp.
 - c. METALAIR, Inc.
- C. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

2.5 DUCT-MOUNTING ACCESS DOORS

- A. General Description: Fabricate doors airtight and suitable for duct pressure class.
- B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill, full perimeter gasket and thickness as indicated for duct pressure class. Include continuous butt or piano hinge and cam locks.
 - 1. Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Flexmaster U.S.A., Inc.

- c. Greenheck.
- d. McGill AirFlow Corporation.
- e. Nailor Industries Inc.
- 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

- C. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.
- D. Insulation: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.6 FLEXIBLE CONNECTORS

- A. Manufacturers:
 - 1. Duro Dyne Corp.
 - 2. Ventfabrics, Inc.
- B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
- C. Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd..
 - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3. Service Temperature: Minus 40 to plus 200 deg F.

2.7 FLEXIBLE DUCTS

- A. Manufacturers:
 - 1. Ductmate Industries, Inc.
 - 2. Flexmaster U.S.A., Inc.
 - 3. Hart & Cooley, Inc.
 - 4. McGill AirFlow Corporation.
- B. Insulated-Duct Connectors: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized 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.
- C. Flexible Duct 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.

2.8 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.

- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts.
- B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- D. Install volume dampers in ducts with liner; avoid damage to and erosion of duct liner.
- E. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.
- F. Provide test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire dampers, with fusible links, according to manufacturer's UL-approved written instructions.
 - 1. Locate all associated actuators in a conditioned space.
 - 2. Access to each actuator and fusible link must be provided for inspection and service.
- H. Label fire dampers according to Division 23 Section "Mechanical Identification."
- I. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:
 - 1. Downstream from volume dampers, turning vanes, and equipment.
 - 2. Adjacent to fire dampers, providing access to reset or reinstall fusible links.
 - 3. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot spacing.
 - 4. On sides of ducts where adequate clearance is available.
 - 5. Minimum size: 16-inch x 16-inch rectangular access doors where possible. Otherwise install as large an access door as height permits by 16-inch in length.
- J. Label access doors according to Division 23 Section "Mechanical Identification."

- K. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.
- L. Connect diffusers boots to low pressure ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- M. Connect flexible ducts to metal ducts with draw bands.
- N. Install duct test holes where indicated and required for testing and balancing purposes.

3.2 ADJUSTING

- A. Adjust duct accessories for proper settings.
- B. Adjust fire dampers for proper action.
- C. Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION 233713

SECTION 237200 - HEAT AND SMOKE VENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes roof hatch type heat and smoke vents with sound transmission class rated for stages and theaters.

1.2 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
 - 1. Hatch Units: Show types, elevations, and full size profiles.
 - 2. Hardware: Show materials, finishes, locations of fasteners, types of fasteners, locations and types of operating hardware, and details of installation.
 - 3. Material gages and finishes.
 - 4. Dampers, including housings, linkages, and operators.
 - 5. Technical data for each type of hatch assembly, including setting drawings, templates, finish requirements, and details of anchorage devices.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASTM Compliance: Products shall comply with sound performance ratings per ASTM E 90 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements and ASTM E 1332 Standard Classification for Rating Outdoor-Indoor Sound Attenuation.
- C. UL Standard: UL Labeled for testing to Underwriters Laboratories Inc, UL 793 Heat and Smoke Vents.
- D. FM Compliance: FM Global, Factory Mutual, FM 4430 Heat and Smoke Vents for Roofs.
- E. NFPA Compliance: NFPA 204 for general maintenance of Heat and Smoke vents.

1.4 WARRANTY

- A. Special Warranty: Manufacturer agrees to replace components of units that fail in materials or workmanship within specified warranty period. The warranty shall include complete replacement costs for parts (non-prorated) and labor. Warranty service labor provided by a factory authorized representative is acceptable.
1. Warranty Period for Entire Assembly: Five (5) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 HEAT AND SMOKE VENTS FOR EMERGENCY HEAT AND SMOKE REMOVAL

- A. Manufacturers: Subject to compliance with requirements, provide products by Babcock-Davis (AcousticMAX Series) or Engineer approved equal.
- B. Type and Size: Acoustical Smoke Vents with the following performance requirements:
1. STC Rating: STC 50 - OITC 39 Rated per ASTM E 90 and OITC rated per ASTM E 1332
 2. Loads: 40-lbf/sq. ft. live load with a maximum deflection of 1/150th of the span; 90 lbf/sq. wind uplift
 3. When release is actuated, lid shall open against 10-lbf/sq. ft. snow or wind load and lock in position.
- C. Size: Refer to Drawing Schedule.
- D. Hatch Material:
1. Cover: 0.07895 inch galvanized steel cover and liner.
 2. Cover Insulation: 2 inch Mineral Wool insulation with sound mat contained within 3-1/4 inch thick covers, providing total thermal resistance of R-10
 3. Curb/Frame: 0.07895 inch galvanized steel curb. 12 inch high double wall curb with EZ tab counterflashing and 5-1/2 inch mounting flange with 1/2 inch diameter holes
 4. Curb Insulation: inch Mineral wool insulation with sound mat contained within 3-3/4 inch thick curb and channel, providing total thermal resistance of R-14
- E. Finish:
1. Cover Exterior: High Reflectance White powder coat steel
 2. Cover Interior: Black powder coat finish
 3. Curb: Black powder coat finish
- F. Latch: Positive hold zinc plated steel rotary latch assembly. Upon latch releases, vent covers are closed manually at rooftop level.
1. Latch released manually via internal and external pull handles with cables.
 2. Latch released automatically by UL 33 listed fusible melt-out link at temperature of 360 deg F.

3. Fire alarm control panel operation: latch release with electrical Belimo motor actuator, 110 V AC
- G. OSHA Compliant Fall Protection Security Mesh: 3/16 inch diameter steel rod, 4 inch by 4 inch spacing, securely attached to inside of curb.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine areas and conditions under which Work is to be performed and identify conditions detrimental to proper or timely completion.
- B. Verify that deck, curbs, roof membrane, base flashing, and other items affecting Work of this Section are in place and positioned correctly.
- C. Verify tolerances and correct improper condition.
- D. Identify conditions detrimental to providing proper quality and timely completions of work.
- E. Do not proceed with installation until detrimental conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's recommendations.
- B. Comply with manufacturer's rigging and installation instructions for unloading units and moving to final locations.
- C. Curb Support: Furnish roof curb for installation by the General Contractor. Roof curbs shall be installed on roof structure according to "The NRCA Roofing Manual."
 1. Install and secure units on curbs and coordinate roof penetrations and flashing with roof construction.
 2. Coordinate size, installation, and structural capacity of roof curbs, equipment supports, and roof penetrations. Coordinate size, location, and installation of unit manufacturer's roof curbs and equipment supports with General Contractor.
 3. Coordinate installation of sealant and roofing cement with Work of this Section to ensure water tightness.
 4. Securely anchor roof accessories in compliance with manufacturer's instructions.
 5. Set units plumb, level, and true to line without warp or rack. Separate metal from incompatible metal or corrosive substrates, including wood, by coating concealed surfaces, at locations of contact, with bituminous coating or providing other permanent separation.
 6. Flange Seals: Unless otherwise indicated, set flanges of accessory units in a thick bed of roofing cement to form a seal.

- D. Provide free standing guardrail system along entire roof edge within 15 feet of roof mounted HVAC unit. Comply with requirements in Section 230515 "Rooftop Fall Protection Guardrails".

3.3 FIELD QUALITY CONTROL

- A. Operational Test: After final fire alarm connections complete and systems ready, test units to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Smoke Vent Testing: Test for proper operation after installation by one or all of the operational methods:
 - 1. Pull internal and/or external manual pull handles and then close vents from the exterior at the roof top level.
 - 2. Open the vents using a fire alarm signal command, then close vents from the exterior at the roof top level.
- C. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.
- D. Do not paint the internal mechanisms, especially moving parts such as spring/dampers, rotary latches and especially the fusible links. Painting any of these components may damage the vents and will void the warranty.

3.4 ADJUSTING

- A. Adjust movable parts for smooth operation.
- B. Operational Units: Test-operate units with operable components. Clean and lubricate joints and hardware. Adjust for proper operation.

3.5 CLEANING

- A. Clean exposed surfaces per manufacturer's written instructions. Touch up damaged metal coatings.

END OF SECTION 237200

SECTION 237433 - ROOFTOP AIR HANDLING 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 factory-packaged rooftop air handling units.
- B. Units shall be capable of supplying up to 100 percent outdoor air and providing conditioned supply air using economizer, mechanical cooling, heating and dehumidification. Heating applications include hydronic heating coil as scheduled. Applicable unit designations include:
 - 1. RTU: Packaged rooftop air handling units controlled for single zone VAV operation or central air handling system serving multiple air terminal units.
 - 2. DOAS: Packaged rooftop dedicated outdoor air handling units controlled for dedicated outdoor air systems serving multiple spaces. Units shall operate in full recirculation mode for unoccupied dehumidification.

1.3 SUBMITTALS

- A. Product Data: For each type of product. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
 - 4. Roof-curb mounting details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - a. Size and location of roof curb and anchor points and methods for anchoring units to roof curb.
 - b. Required roof penetrations for ducts, pipes, and electrical raceways, including size and location of each penetration.
- C. Product Certificates: For certification required in "Quality Assurance" Article.
- D. Source quality-control reports.
- E. Field Test Reports: Include startup service reports.

- F. Manufacturer's Warranties: Written warranty for the period stated within, signed by the manufacturer.
- G. Manufacturer's Operation and Maintenance Manuals
- H. Instructional Videos: Including those that are prerecorded and those that are recorded during training.

1.4 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: Two (2) sets for each unit.

1.5 WARRANTY

- A. Special Warranty: Manufacturer agrees to replace components of units that fail in materials or workmanship within specified warranty period including parts and labor.
 - 1. Full Packaged Rooftop Air Handling Unit Warranty: – Two (2) years from Substantial Completion.
 - 2. Warranty Period for Compressors: Five (5) years from date of Start-Up.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following (refer to front end for bid alternates):
 - 1. Addison (Basis of Design)
 - 2. Greenheck
 - 3. Johnson Controls
- B. Where equipment size, weight, or electrical requirements differ from the design or scheduled design information for the Basis of Design manufacturer, submit in writing the associated increased size, weight, or electrical requirements with the proposal. The intent is to review the impact of any potential related changes for the roofing, structural or electrical scopes of work during the proposal review period and de-scope meetings.

2.2 PERFORMANCE REQUIREMENTS

- A. General Fabrication Requirements:
 - 1. 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. Unit wiring shall comply with NEC requirements.

2. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."
3. Comply with requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Start-up."
4. Comply with requirements in ASHRAE 90.1-2016.
5. Comply with ARI 270, "Sound Rating of Outdoor Unitary Equipment."

B. Cabinet Thermal Performance:

1. Maximum Overall U-Value: Comply with requirements in ASHRAE/IESNA 90.1.
2. Include effects of metal-to-metal contact and thermal bridges in the calculations.

C. Cabinet Surface Condensation:

1. Cabinet shall have additional insulation and vapor seals if required to prevent condensation on the interior and exterior of the cabinet.
2. Portions of cabinet located downstream from the cooling coil shall have a thermal break at each thermal bridge between the exterior and interior casing to prevent condensation from occurring on the interior and exterior surfaces. The thermal break shall not compromise the structural integrity of the cabinet.

D. Maximum Cabinet Leakage: 1 percent of the total supply-air flow at a pressure rating equal to the fan shut-off pressure.

E. Cabinet Deflection Performance:

1. Walls and roof deflection shall be within 1/240 of the span at the design working pressure equal to the fan shut-off pressure. Deflection limits shall be measured at any point on the surface.
2. Floor deflections shall be within 1/300 of the span considering the worst-case condition caused by the following:
 - a. Service personnel.
 - b. Internal components.
 - c. Design working pressure defined for the walls and roof.

F. Electrical components, devices, and accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 CABINET

- A. Construction: double wall.
- B. Exterior Casing Material: Galvanized steel with powder coat paint finish. Exterior to withstand 750-hour salt spray test per ASTM B117.
- C. Interior Casing Material: Galvanized steel.
- D. Lifting and Handling Provisions: Factory-installed shipping skids and lifting lugs.
- E. Base Rails: Galvanized-steel rails for mounting on roof curb.

- F. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
 - 1. Service Doors: Access doors with gaskets, stainless steel hinges and quarter turn latches. Material and construction of doors shall match material and construction of cabinet in which doors are installed.
- G. Roof: Standing seam or membrane; sloped to drain water.
- H. Floor: Reinforced, metal surface; reinforced to limit deflection when walked on by service personnel. Insulation shall be below metal walking surface.
- I. Cabinet Insulation:
 - 1. Type: Fibrous-glass duct lining complying with ASTM C 1071, Type II or flexible elastomeric insulation complying with ASTM C 534, Type II, sheet materials.
 - 2. Thickness: 2 inches.
 - 3. Insulation Adhesive: Comply with ASTM C 916, Type I.
 - 4. Mechanical Fasteners: Suitable for adhesive, mechanical, or welding attachment to casing without damaging liner and without causing air leakage when applied as recommended by manufacturer.
- J. Condensate Drain Pans:
 - 1. Shape: Rectangular, with 1 percent slope in at least two planes to direct water toward drain connection.
 - 2. Size: Large enough to collect condensate from cooling coils including coil piping connections, coil headers, and return bends.
 - 3. Material: Stainless-steel sheet.
- K. Roof Curb: Full-perimeter curb assembly, fully assembled with solid bottom, minimum 14-inch high, with 1.5-inch-thick neoprene coated rigid insulation, wood nailer, neoprene sealing strip, and welded Z-bar flashing. Where scheduled, provide 32-inch high roof curbs with framed openings for horizontal duct connections.
 - 1. Comply with requirements in "The NRCA Roofing Manual".

2.4 SUPPLY AND EXHAUST FANS

- A. Supply and exhaust fans shall be single width, single inlet (SWSI) airfoil centrifugal fans. Fan wheels shall be Class II construction with blades that are continuously welded to the hub plate and end rim. Supply and exhaust fans shall be direct drive fan mounted to the motor shaft.
- B. Supply and exhaust fan assemblies shall employ solid steel fan shafts. The entire fan assembly shall be isolated from the fan bulkhead with a flexible collar. All fan assemblies shall be statically and dynamically balanced at the factory, including a final trim balance.
- C. Supply and exhaust fans shall be capable of airflow modulation from 30% to 100% of the scheduled design airflow. Fans shall not operate in a state of surge at any point within the modulation range.

- D. Electronically Commutated Motors (ECM):
 - 1. Enclosure: Totally enclosed EC motor.
 - 2. Thermal overload protection.
 - 3. Efficiency: Premium efficient.
 - 4. Service Factor: 1.15.
- E. Factory mounted and wired variable frequency drives are an acceptable alternative to ECM controlled fans. Refer to Section 230512 for variable frequency drive requirements.

2.5 COOLING COILS

- A. Capacity Ratings: Comply with ASHRAE 33 and ARI 410 and coil bearing the ARI label.
- B. Coil Casing Material: Galvanized steel or stainless steel.
- C. Tube Material: Copper.
- D. Tube Header Material: Copper or red brass.
- E. Fin Material: Aluminum.
- F. Fin and Tube Joints: Mechanical bond.
- G. Leak Test: Coils shall be leak tested with air underwater.
- H. Refrigerant Coil Suction and Distributor Header Materials: Seamless copper tube with brazed joints.
- I. Drain Pan Overflow Protection: A drain pan overflow safety shall shut off the unit and issue a diagnostic warning before overflow occurs.

2.6 REFRIGERATION SYSTEM

- A. Comply with requirements in ASHRAE 15, "Safety Standard for Refrigeration Systems."
- B. Refrigerant Charge: Factory charged with refrigerant and filled with oil.
- C. Compressors: Digital scroll variable capacity compressors with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief, and crankcase heater. Each compressor shall have a separate oil pump, oil separator and low oil safety protection.
- D. Refrigerant: R-410A.
 - 1. Classified as Safety Group A1 according to ASHRAE 34.
 - 2. Provide unit with operating charge of refrigerant.

- E. Refrigeration System Specialties: electronic controlled expansion valve, high and low-pressure transducer, high pressure safety, suction and discharge temperature sensors, suction pressure sensors, and bypass valve between suction and discharge for low head pressure starting.
 - 1. Reversing valve, low ambient temperature sensor and safety, and additional specialties required for air-source heat pumps.
- F. Modulating hot gas reheat coil.
- G. Microchannel condenser coil.
- H. Low ambient operation.
- I. Refrigerant condenser and reheat condenser coils:
 - 1. Capacity Ratings: Complying with ASHRAE 33 and ARI 410 and coil bearing the ARI label.
 - 2. Tube Material: Copper.
 - 3. Fin Material: Aluminum.
 - 4. Fin and Tube Joint: Mechanical bond.
 - 5. Leak Test: Coils shall be leak tested with air underwater.
- J. Condenser Fan Assembly:
 - 1. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades.
 - 2. Fan Safety Guards: Steel with corrosion-resistant coating.

2.7 HOT-WATER HEATING COIL

- A. Capacity Ratings: Comply with ASHRAE 33 and ARI 410 and coil bearing the ARI label.
- B. Coil Casing Material: Galvanized steel or stainless steel.
- C. Tube Material: Copper.
- D. Tube Header Material: Copper or red brass.
- E. Fin Material: Aluminum.
- F. Fin and Tube Joints: Mechanical bond.
- G. Leak Test: Coils shall be leak tested with air underwater.
- H. Connections for unit mounted coils: Coil connection stubs located inside the unit cabinet with piping chase within the unit equipment rail.

2.8 ENERGY RECOVERY WHEEL

- A. Provides sensible and latent energy recovery.

- B. Unitary design with slide-out wheel cassette and track.
- C. Bypass dampers for economizer operation.
- D. Integrated unit control of wheel speed for temperature and defrost control.

2.9 OUTDOOR-AIR INTAKE HOOD

- A. Type: Outdoor air connection with motorized damper and exhaust air connection with barometric damper.
- B. Materials: Match cabinet.
- C. Bird Screen: Comply with requirements in ASHRAE 62.1.
- D. Configuration: Designed with hoods or louvers to inhibit wind-driven rain and snow from entering unit.

2.10 FILTERS

- A. Extended-Surface, Disposable Panel Filters for return / exhaust and outdoor air paths:
 - 1. Comply with NFPA 90A.
 - 2. Factory-fabricated, dry, extended-surface type.
 - 3. Thickness: 2 inches.
 - 4. Minimum MERV-8 according to ASHRAE 52.2.
 - 5. Media: Fibrous material formed into deep-V-shaped pleats.
- B. Mounting Frames:
 - 1. Panel filters arranged for flat or angular orientation. Filters shall be removable from one side.
 - 2. Galvanized or stainless steel with gaskets and fasteners.

2.11 ELECTRICAL POWER CONNECTIONS

- A. General Electrical Power Connection Requirements: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a single-point field power connection to unit.
- B. Enclosure: NEMA 250, Type 3R, mounted in unit with hinged access door in unit cabinet having a lock and key or padlock and key,
- C. Wiring: Numbered and color-coded to match wiring diagram.
- D. Wiring Location: Install factory wiring outside an enclosure in a raceway.
- E. Power Interface: Field power interface shall be to NEMA KS 1, heavy-duty, fused disconnect switch and 35,000 amp SCCR capability.

- F. Factory Wiring: Branch power circuit to each motor and to controls with fused disconnect switch.
- G. Factory-Mounted, Overcurrent-Protection Service: For each motor.
- H. Transformer: Factory mounted with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
- I. Receptacle: Factory wired unit-mounted, ground fault interrupt (GFI) duplex receptacle with outlet disconnect switch in unit control panel.
- J. Control Relays: Auxiliary and adjustable time-delay relays.
- K. The system shall have a voltage monitor with phase protection.

2.12 CONTROLS

- A. Provide terminal strip for full DDC control by BAS. The BAS shall directly control the following components with a modulating control signal (typically 0-10 or 2-10 VDC).
 - 1. Supply Fan VFD (or ECM).
 - 2. Exhaust Fan VFD (or ECM).
 - 3. Digital scroll compressor(s).
 - 4. Hot gas reheat valve.
- B. Control Wiring: Factory wire control transformer for controls' power supply.
- C. Control Devices: Sensors, transmitters, relays, switches, detectors, operators, actuators, and valves shall be manufacturer's standard items to accomplish indicated control functions.
- D. Outdoor, Return and Exhaust Air Control Dampers:
 - 1. Damper Location: Factory installed inside unit for ease of blade axle and bushing service. Arrange dampers located in a mixing box to achieve convergent airflow to minimize stratification.
 - 2. Damper Leakage: Comply with requirements in AMCA 500-D. Leakage shall not exceed 6.5 cfm per sq. ft. at a static-pressure differential of 4.0 inches water column when a torque of 5 inch pounds per sq. ft. is applied to the damper jackshaft.
 - 3. Damper Rating: Rated for close-off pressure equal to the fan shutoff pressure.
 - 4. Damper Label: Bear the AMCA seal for both air leakage and performance.
 - 5. Blade Configuration: Unless otherwise indicated, use parallel blade configuration for two-position control and equipment isolation service and use modulating control when mixing two airstreams. For other applications, use an opposed-blade configuration.
 - 6. Damper Frame Material: Extruded aluminum galvanized steel or stainless steel.
 - 7. Blade Type: Single-thickness metal reinforced with multiple V-grooves or hollow-shaped airfoil.
 - 8. Blade Material: Extruded aluminum galvanized steel or stainless steel.
 - 9. Maximum Blade Width: 6 inches.
 - 10. Maximum Blade Length: 48 inches.

11. Blade Seals: Replaceable, continuous perimeter vinyl seals and jambs with stainless-steel compression-type seals.
12. Bearings: Thrust bearings for vertical blade axles.

E. Damper Operators:

1. Factory-installed electric operator for each damper assembly with one operator for each damper assembly mounted to the damper frame.
2. Operator capable of shutoff against fan pressure and able to operate the damper with sufficient reserve power to achieve smooth modulating action and proper speed of response at the velocity and pressure conditions to which the damper is subjected.
3. Adjustable Stops: For both maximum and minimum positions.
4. Spring-return operator to fail-safe; either closed or open as required by application.
5. Operator Type: Direct coupled, designed for minimum 60,000 full-stroke cycles at rated torque.
6. Coupling: V-bolt and V-shaped, toothed cradle.
7. Circuitry: Electronic overload or digital rotation-sensing circuitry.

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 piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.
- C. Examine roof curbs and equipment supports for suitable conditions where units will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's rigging and installation instructions for unloading units and moving to final locations.
- B. Install units level and plumb, maintaining manufacturer's recommended clearances.
- C. Arrange installation of units to provide access space around rooftop air-handling units for service and maintenance.
- D. Curb Support: Furnish roof curb for installation by the General Contractor. Roof curbs shall be installed on roof structure according to "The NRCA Roofing Manual".

1. Install and secure units on curbs and coordinate roof penetrations and flashing with roof construction.
 2. Coordinate size, installation, and structural capacity of roof curbs, equipment supports, and roof penetrations. Coordinate size, location, and installation of unit manufacturer's roof curbs and equipment supports with General Contractor.
- E. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

3.3 CONNECTIONS

- A. Where installing piping adjacent to units, allow space for service and maintenance.
- B. Hydronic Piping Connections:
1. Comply with requirements in Section 232113 "Hydronic Piping".
 2. Comply with drawing detail for heating coil freeze protection pump application. Locate pump in adjacent storage room as indicated on drawings.
- C. Install condensate drain piping from unit drain pans to discharge on a 24-inch x 24-inch x 2-inch concrete paver. Provide trap cleanout and drain plugs.
1. Drain Piping: Schedule 40 galvanized steel or copper.
 2. Pipe Size: Same size as condensate drain pan connection.
- D. Duct Connections:
1. Comply with requirements in Section 233113 "Metal Ducts."
 2. Connect ducts to units with flexible duct connectors.
 3. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
 4. Provide 6-inch thick fiberglass batt insulation, formaldehyde-free, covering full area of the roof curb bottom.
 5. Provide connections to horizontal supply-air and return-air ductwork exposed outdoors (as applicable).
 6. Refer to Section 230713 for duct insulation exposed outdoors (as applicable).
- E. Electrical: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.
- F. Ground equipment according to Division 26 Section "Grounding and Bonding."

3.4 FIELD QUALITY CONTROL

- A. The rooftop air handling unit manufacturer shall provide a Factory Authorized Service Engineer, employed by the manufacturer, to perform the start-up procedures as outlined in the Start-up, Operation and Maintenance manual provided by the manufacturer. Complete the manufacturer's installation and start-up checklists and record all readings.
- B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

- C. Visually inspect rooftop air handling units for damage before starting. Repair or replace damaged components, including insulation. Do not start equipment until damage that is detrimental to operation has been corrected.
- D. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
 - 1. Inspect units for visible damage to refrigerant compressor, condenser and evaporator coils, and fans.
 - 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 - 3. Set field-adjustable switches and circuit-breaker trip ranges.
 - 4. Confirm continuity of double wall casing and enclosed casing insulation.
 - 5. Verify that clearances have been provided for servicing.
 - 6. Verify that filters are installed.
 - 7. Verify coils are clean and inspect for construction debris.
 - 8. Inspect and adjust vibration isolators.
 - 9. Verify bearing lubrication.
 - 10. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
 - 11. Inspect energy recovery wheel rotation for movement in correct direction without vibration and binding.
 - 12. Verify that controls are connected and operable.
 - 13. Test and adjust controls and safeties.
 - 14. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
 - 15. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation, unit operation and compliance with requirements.
 - 16. Inspect outdoor-air and return-air dampers for proper stroke.
 - 17. Simulate maximum cooling demand and inspect refrigerant pressures, compressor cycling and capacity modulation.
 - 18. Simulate maximum heating demand and inspect capacity modulation.
 - 19. Verify operational sequence of controls.
- E. Following start-up, the manufacturer shall submit a report of his findings, including the completed start-up report and checklists.
- F. Remove and replace malfunctioning units and retest as specified above.
- G. Occupancy Adjustments: When requested within 12 months of date of start-up, 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.

3.5 DEMONSTRATION

- A. After the above start-up services have been performed, a factory-trained representative shall provide two training sessions for operations personnel. The representative shall be available for two non-consecutive instruction periods within six months of start-up, not to exceed four (4) hours each. Training shall include start-up and shut-down, servicing and preventative maintenance schedule and procedures, and troubleshooting procedures plus procedures for obtaining repair parts and technical assistance. All information shall be included in the Operating and Maintenance Manuals.

- B. The applicable rooftop air handling unit manufacturer's service literature shall be available during instruction and consulted for guidelines concerning preventative maintenance.
- C. Schedule first training session with Owner with a minimum two-week advanced notice.
Schedule second training session with Owner within six months of start-up.

END OF SECTION 237433

SECTION 238236 – FINNED TUBE RADIATION AND CONVECTORS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes finned tube radiation and convectors.

1.2 SUBMITTALS

- A. Product Data: Include specialties and accessories for each finned tube radiation and convector type indicated.
- B. Shop Drawings: Show the following:
 - 1. Plans, elevations, sections, and details.
 - 2. Required clearances.
 - 3. Location and size of each field connection.
 - 4. Enclosure joints, corner pieces, access doors, and other accessories.
 - 5. Unit schedules to include rated capacities, furnished specialties, and accessories.
- C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- 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."

PART 2 - PRODUCTS

2.1 HOT WATER FINNED TUBE RADIATION

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Rittling
 - 2. Sterling
- B. Provide hot water finned tube radiation of lengths and in locations as indicated, and of capacities, style, tiers, fin size, and enclosure height and having accessories as scheduled.
 - 1. Enclosures shall be constructed of 16-gauge steel with overlapping type slip joints and baked powder coat finish in manufacturer's standard color as selected by Architect.
 - 2. Extruded aluminum discharge grille.
 - 3. Copper / aluminum mechanically expanded elements.

4. Ball bearing brackets for wall mounting.
5. Partial backplate.
6. NPT thread piping connections.
7. Wall trims, corners and end caps as required (custom sized based on field measurements).

2.2 HOT WATER CONVECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Rittling
 2. Sterling
- B. Provide hot water convectors of size and in locations as indicated, and of capacities and configuration and having accessories as scheduled.
 1. Enclosures shall be constructed of 16-gauge steel fronts / tops and 18-gauge backs / sides with baked powder coat finish in manufacturer's standard color as selected by Architect.
 2. Louvered inlet.
 3. Bronze header with copper / aluminum mechanically expanded elements.
 4. Back side factory insulation.
 5. NPT thread piping connections.
 6. Access doors.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install finned tube radiation and convectors as follows:
 1. Install per manufacturer's instructions.
 2. Coordinate locations to provide clearance from electrical receptacles.
 3. Provide low point drains for all piping risers.

3.2 CONNECTIONS

- A. Connect hot-water units and components to piping according to Division 23 Section "Hydronic Piping."
- B. Connect finned tube radiation and convectors to supply with ball valve, strainer, control valve, PT-plug and union or flange; and to return with ball valve, balancing valve, PT-plug and union or flange.
- C. Where finned tube radiation is installed in series with a fan coil unit or VAV box heating coil, the circuit shall have a common control valve. Refer to detail on drawings.

END OF SECTION 238236

SECTION 238238 - CABINET AND UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes cabinet and unit heaters.

1.2 SUBMITTALS

- A. Product Data: Include specialties and accessories for each unit type and configuration indicated.
- B. Shop Drawings:
 - 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.
 - 4. Equipment schedules to include rated capacities, furnished specialties, and accessories.
- C. Field quality-control test reports.
- D. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Heating equipment shall be UL Listed by Underwriters Laboratories or ETL Listed by Electrical Testing Laboratories (division of Intertek Testing Laboratories).

1.4 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Furnish two (2) sets of spare filters for each cabinet unit heater.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide hydronic cabinet and unit heaters by one of the following:
 - 1. Hydronic Cabinet and Unit Heaters
 - a. Airtherm
 - b. Rittling
 - c. Sterling; Division of Mestek, Inc.
- B. Refer to drawing schedules for basis of design manufacturer and series / base model of electric heating units.

2.2 HYDRONIC CABINET AND UNIT HEATERS

- A. Description: An assembly including cabinet, filter, chassis, coil, fan, and motor in blow-through configuration with heating coil. Refer to equipment schedule for specific mounting configuration.

2.3 MATERIALS

- A. Chassis: Galvanized steel, with flanged edges.
- B. Coil Section Insulation: 1-inch duct liner complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
 - 1. Fire-Hazard Classification: Duct liner and adhesive shall have a maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
- C. Cabinet: Galvanized steel, with removable panels fastened with tamperproof fasteners.
- D. Cabinet Finish: Bonderize, phosphatize, and flow-coat with baked-on primer with manufacturer's standard paint, in color selected by Architect, applied to factory-assembled and -tested cabinet unit heater before shipping.
- E. Filters: 1-inch thick, pleated MERV-6.

2.4 HYDRONIC COILS

- A. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and with manual air vent. Coils shall be rated for a minimum working pressure of 300 psig and a maximum entering water temperature of 225 deg F, with manual air vent.

2.5 FAN

- A. Centrifugal, with forward-curved, double-width wheels and fan scrolls made of galvanized steel; directly connected to motor.

2.6 FAN MOTORS

- A. Permanent-split capacitor, multispeed motor with factory mounted and wired power disconnect switch, integral thermal-overload protection and resilient mounts.

2.7 ACCESSORIES

- A. Steel recessing flanges for recessing cabinet unit heaters into ceiling or wall.

2.8 SOURCE QUALITY CONTROL

- A. Test cabinet unit heater coils according to ASHRAE 33.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cabinet and unit heaters to comply with NFPA 90A.
- B. Suspend cabinet and unit heaters from structure with rubber-in-shear vibration isolators (rubber hangers).

3.2 CONNECTIONS

- A. Install units to allow service and maintenance.
- B. Connect cabinet and unit heaters to supply with ball valve, strainer, control valve, PT-plug and union or flange; and to return with ball valve, balancing valve, PT-plug and union or flange.
- C. Install thermostats and control wiring in accordance with manufacturer's instructions.

3.3 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing and report results in writing:
 - 1. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Test and adjust controls and safeties.

- B. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

END OF SECTION 238238

SECTION 238551 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following ceiling- and wall-mounted air outlets and inlets:
 - 1. Diffusers.
 - 2. Grilles.

1.2 SUBMITTALS

- A. Product Data: For each model indicated, include the following:
 - 1. Data Sheet: Indicate construction, finish, and mounting details for each type of air outlet, inlet, and accessory indicated.
 - 2. Performance Data: Include throw and drop, static-pressure drop, and noise ratings for each type of air outlet and inlet indicated.
 - 3. Schedule of diffusers, registers, and grilles indicating drawing designation, room location, quantity, model number, size, and accessories.

1.3 QUALITY ASSURANCE

- A. NFPA Compliance: Install diffusers, registers, and grilles according to NFPA 90A, "Standard for the Installation of Air-Conditioning and Ventilating Systems."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Diffusers, registers, and grilles are scheduled on Drawings. Subject to compliance with requirements, provide products by one of the following:
 - 1. Anemostat Products, Dynamics Corp. of America.
 - 2. Carnes Co. Inc.
 - 3. Krueger Manufacturing Co.
 - 4. Hart & Cooley, Inc., Tuttle & Bailey Div.
 - 5. Titus
 - 6. Price Industries

2.2 SOURCE QUALITY CONTROL

- A. Testing: Test performance according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Ceiling and Wall 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 practicable. For units installed in lay-in ceiling panels, locate units in the center of the panel. Install diffusers, registers, and grilles with airtight connection to ducts and to allow service and maintenance of dampers and fire dampers.

END OF SECTION 238551

SECTION 238738 - SPLIT-SYSTEM AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes:
 - 1. Split-system air-conditioning or heat pump units consisting of separate evaporator-fan and compressor-condenser components. Ductless units are designed for ceiling cassette mounting.

1.2 DEFINITIONS

- A. Evaporator-Fan Unit: The part of the split-system air-conditioning unit that contains a coil for cooling and a fan to circulate air to conditioned space.
- B. Compressor-Condenser or Heat Pump Unit: The part of the split-system air-conditioning unit that contains a refrigerant compressor and a coil for condensing refrigerant.

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each unit indicated. Include performance data in terms of capacities, sound power characteristics, motor requirements, and electrical characteristics.
- B. Wiring Diagrams: Power, signal, and control wiring.
- C. Start-Up, Operation, and Maintenance Data: Detailed manuals including procedures and schedules for starting up and shutting down, troubleshooting, servicing, and maintaining units.
- D. Manufacturer's Warranties: Written warranty for the period stated within, signed by the manufacturer.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Code for Mechanical Refrigeration."
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

- D. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- E. Seasonal Energy-Efficiency Rating: Equal to or greater than scheduled values and prescribed by ASHRAE 90.1-2013, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings" and 2015 International Energy Conservation Code.
- F. Comply with UL 303, "Refrigeration and Air-Conditioning Condensing and Compressor Units."

1.5 WARRANTY

- A. Special Warranty: Manufacturer agrees to replace components of units that fail in materials or workmanship within specified warranty period including parts and labor.
 - 1. Full Unit Warranty – Two (2) years from Substantial Completion.
 - 2. Warranty Period for Compressors: Five (5) years from Substantial Completion.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Furnish two (2) sets of spare filters for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Ductless Split System Air Conditioning Units: Subject to compliance with requirements, provide products by one of the following:
 - 1. Mitsubishi Electric Corp.
 - 2. Daikin Applied
 - 3. LG Electronics U.S.A.

2.2 DUCTLESS EVAPORATOR-FAN UNIT

- A. Cabinet: Durable ABS plastic cabinet with a galvanized steel sub-chassis.
 - 1. Recessed Ceiling Cassette: Airflow settings for high and low ceiling applications. Individual vane settings for direct/indirect airflow control or variable airflow patterns.
 - 2. Insulation: Foil faced, glass-fiber, duct liner with 4.2 "R" value.
 - 3. Drain Pans: Condensate drain pan constructed of high temperature ABS plastic with anticorrosion coating; insulated and internally sloped.
 - 4. Built-in condensate lift mechanism.

5. Condensate Drain Pan Level Sensor: Device will sense a high condensate level in the drain pan that will shut down the indoor unit before an overflow condition. An error code shall be produced indicating a fault which must be resolved before the unit re-starts. Powered by a 20-year life Lithium battery, factory installed prior to shipment. No external electric power needed for operation. There is an audible indication of low battery condition if replacement needed.
 - B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with factory-installed, inverter-tuned thermal expansion valve.
 - C. Refrigeration System: Built-in compatibility with multi-stage / variable speed cooling application.
 - D. Evaporator Fan: Direct-drive DC (ECM) type fan with statically and dynamically balanced impeller. Fan motor bearings shall be permanently lubricated. Fan motor thermally protected.
 - E. Filters:
 1. Comply with NFPA 90A.
 2. MERV-4, washable; Filters shall be removable from bottom of unit.
 - F. Controls: Single wall-mounted wired controller with LCD backlit display for each unit.
 1. Wall mounted microprocessor controller: Low voltage controller with sub-base to control compressor and evaporator fan.
 2. Operation Modes: Cool / Auto / Fan only
 3. Adjustable temperature setting
 4. Measured space temperature displayed
 5. 7 day timer (ON/OFF, Set Temperature)
 6. Fan Speed Setting: Hi/Mid/Low/Auto
 7. Airflow Direction Setting: 100 - 80 - 60 - 40 degree angles and oscillate
 8. Individual prohibit operations for each remote controller function (ON/OFF, Set Temperature, Operation Mode, and Filter reset)
 9. Filter change indicator with reset
 10. Error code displayed
 11. The microprocessor shall monitor the condensate pump safety switch and display an error code when a fault occurs.
 12. Non-volatile back-up memory shall maintain control settings for an indefinite period during a power outage. When power is restored the equipment shall resume operation after compressor time delay.
- 2.3 AIR-COOLED, COMPRESSOR-CONDENSER / HEAT PUMP UNIT – DUCTLESS SYSTEMS
- A. Heavy-duty, commercial-grade cabinet constructed of galvanized steel plate, finished with electrostatically applied, thermally fused acrylic or polyester powder coating for superb corrosion protection. The front fan grille shall be high-impact ABS plastic.
 - B. Provide brass service valves, fittings, and gage ports on exterior of casing.

- C. Compressor: Inverter-driven compressors, DC twin-rotor type with Pulse Amplitude Modulation (PAM) circuitry. Variable-speed operation shall vary the compressor speed dynamically to adapt continuously to the room load.
- D. Refrigerant: R-410A.
- E. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240. Provide solid core filter drier.
- F. Fan: Aluminum-propeller type, directly connected to motor.
- G. Motor: Permanently lubricated, with integral thermal-overload protection.
- H. Entire assembly shall be assembled, wired, and test-run at the factory.
- I. System shall satisfy a maximum allowable refrigerant pipe length of 150 feet.
- J. Low Ambient Wind Baffle: Permits operation down to 0 deg F.

2.4 REFRIGERATION ACCESSORIES

- A. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; flared fittings at both ends; factory-insulated suction and liquid lines are acceptable that satisfy minimum insulation thickness requirements.
- B. Diamondback ball valves equipped with Schrader valve for refrigerant service; full port design with flare connections; forged brass body with seal cap design to permit valve operation without removal of seal cap; polytetrafluoroethylene seals and gaskets (no synthetic O-rings); 700 psig rated; refrigerant R-410A compatible.

2.5 ROOF CURBS

- A. Equipment Roof Curbs: Premanufactured solid cover equipment base assembly with heavy gauge galvanized steel, unitized construction, minimum 1.5-inch thick rigid insulation on all sides, 4-inch raised cant, pressure treated wood nailer, exterior grade fire retardant plywood deck with supplemental bracing, 18 gauge galvanized steel top, continuous welded corner seams, and counterflashing with lag screws. Internally reinforced to conform with manufacturer's load bearing factors. Curb shall have galvanized sleeve and pitch pocket for piping penetration (through side) located minimum 12 inches above the roof. Minimum curb height 24 inches. Provide products by The Pate Company or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install roof-mounted units on premanufactured equipment roof curbs. Furnish roof curbs for installation and flashing by the General Contractor.
- B. Provide molded neoprene-in-shear vibration isolators for unit mounting.
- C. Label units according to requirements specified in Division 23 Section "Mechanical Identification."

3.2 CONNECTIONS

- A. Connect condensate drain pans and condensate removal pumps using Type L copper tubing. Pipe size shall be minimum 1-inch for individual units. Discharge to indirect waste receptor or mop receptor. Install cleanouts at changes in direction.
- B. Contractor shall coordinate refrigerant piping layout and refrigerant piping sizes in accordance with the manufacturer's instructions.
- C. Connect refrigerant tubing to component's quick-connect fittings. Provide ball valves equipped with Schrader valve for refrigerant service. Install tubing to allow access to unit and service valves.
- D. Install wall mounted microprocessor controller / thermostat for each ductless unit. Enable auto-restart on each outdoor unit. On the outdoor unit main circuit board set dip switch positions to enable auto-restart.

3.3 FIELD QUALITY CONTROL

- A. Installer Qualifications: Contractor shall utilize manufacturer certified technicians for system installation.
- B. Installation Inspection: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections, and to prepare a written report of inspection.
- C. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- D. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new components, and retest.
- E. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- F. Remove and replace components that do not properly operate and repeat startup procedures as specified above.
- G. Prepare written report of the results of startup services.

3.4 DEMONSTRATION

- A. Operator and Maintenance Training: Provide services of a factory-authorized service representative to instruct Owner's personnel in operation and maintenance procedures to maintain units. Training shall include start-up and shut-down, servicing and preventative maintenance schedule and procedures, and troubleshooting procedures plus procedures for obtaining repair parts and technical assistance. All information shall be included in the Operating and Maintenance Manuals.

END OF SECTION 238738

SECTION 260100 - GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division-1 Specifications sections, apply to work specified in this section.

1.2 SCOPE OF PROJECT:

- A. Provide a complete and operating electrical installation in accordance with these specifications and accompanying contract drawings. This includes all required labor, materials, apparatus and supervision.
- B. Without limiting or restricting the volume of work and solely for the convenience of the Contractor, the work to be performed in general, comprises the following:
 - 1. Auditoriums, Locker room, and classrooms lighting systems.
 - 2. Locker room power system.
 - 3. Final connections to all equipment, unless otherwise noted.
 - 4. Extend existing Fire alarm systems.
 - 5. Lighting controls.
 - 6. Structured cabling.
 - 7. Local AV sound system inputs relocation.

1.3 INTENT OF THIS SECTION:

- A. This Section is intended as a supplement to each of the following Sections of Division 26, 27, 28 ELECTRICAL.
- B. Consider each article of this Section as a part of each of the following Sections insofar as such requirements may be termed applicable.

1.4 TRUE INTENT:

- A. The Drawings and Specifications are intended to provide a complete and perfectly operating system. Therefore, it is specifically agreed and understood by the Contractor that anything, be it labor, material or equipment, which is not described in the Specifications or specifically shown on the Drawings, but is necessary for the operation and completion of a perfectly operating system, according to the true intent of the Specifications and Drawings and as interpreted by the architect, shall be furnished by the Contractor as a part of his Contract, at no extra charge, as though it were specifically detailed and described.

1.5 DEFINITIONS:

- A. General - Basic Contract definitions are included in the Conditions of the Contract.
- B. Indicated - The term indicated refers to graphic representations, notes, or schedules on the Drawings, or other Paragraphs or Schedules in the Specifications, and similar requirements in the Contract Documents. Terms such as shown, noted, scheduled, and specified are used to help the reader locate the reference. There is no limitation on location.
- C. Directed - Terms such as directed, requested, authorized, selected, approved, required, and permitted mean directed by the Architect, requested by the Architect, and similar phrases.
- D. Approved - The term approved, when used in conjunction with the Architect's action on the Contractor's submittals, applications and requests, is limited to the Architects duties and responsibilities as stated in the Conditions of the Contract.
- E. Regulation - The term regulation includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. Furnish - The term furnish means supply and deliver to the Project Site, ready for unloading, unpacking, assembly, installation and similar operations.
- G. Install - The term install describes operations at the Project site including the actual unloading, unpacking, assembly, erection, placing anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- H. Provide - The term provide means to furnish and install, complete and ready for the intended use.
- I. Contractor - The Contractor or Electrical Contractor - The term means the Contractor responsible for all work under this section.
- J. Installer - An installer is the Contractor or another entity engaged by the Contractor, either as an employee, subcontractor, or contractor of lower tier, to perform a particular construction activity, including installation, erection, application, and similar operations. Installers are required to be experienced in the operations they are engaged to perform.
 - 1. The term experienced, when used with the term installer, means having a minimum of five previous projects similar in size and scope to this project, being familiar with the special requirements indicated, and having complied with requirements of the authority having jurisdiction.

2. Trades - Using terms such as carpentry is not intended to imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as carpenter. It also does not imply that requirements specified apply exclusively to tradespersons of the corresponding generic name.
 3. Assigning Specialists - Certain Section of the Specifications require that specific construction activities are performed by specialists who are recognized experts in those operations. The specialists must be engaged for those activities, and their assignments are requirements over which the Contractor has no choice or option. However, the ultimate responsibility for fulfilling Contract requirements remains with the Contractor.
 - a. This requirement is not to be interpreted to conflict with enforcing building codes and similar regulations governing the Work. It is also not intended to interfere with local trade union jurisdictional settlements and similar conventions.
- K. Testing Agencies - A testing agency is an independent entity engaged to perform specific inspections or tests, either at the Project site or elsewhere, and to report on and, if required, to interpret results of those inspections or tests.

1.6 VISITS TO SITE:

- A. Attention is directed to the necessity for all the Electrical Contractor to visit the site and examine all conditions affecting the proper execution of this Contract. Submission of proposals shall be considered evidence that Contractors have visited and examined the site.
- B. Existing contours and topography as indicated, are believed to be reasonably correct, but are not guaranteed. Where conditions at project site do not agree exactly with conditions as indicated, Contractor shall assume all responsibility for said discrepancy.
- C. No extra payment will be allowed the Electrical Contractor for extra work caused by failure to visit, examine and clarify.

1.7 GENERAL:

- A. Throughout the Specifications, types of material are specified by manufacturer's name. Where more than one manufacturer is mentioned, catalog and specification data is given for a specific manufacturer. Equal material produced by other manufacturers listed is acceptable. Refer to SPECIAL REQUIREMENTS - Division 1 for substitution of materials.

1.8 RULES AND REGULATIONS

- A. Perform in accordance with the rules and regulations of the National Electric Code (NEC), International Building Code (IBC) and other Codes and Standards cited in this specification and the requirements of the Utility Companies serving this project.

- B. Certificates of Approval in triplicate, for rough and finished wiring from a Certified Inspection Service must be delivered to the Engineer before final payment can be authorized.
- C. Perform all work in accordance with the rules and regulations of the Pennsylvania Department of Labor and Industry, Federal Department of Labor (Occupational Safety and Health Administration) and any other national, state, or local authority having jurisdiction.
- D. Perform all Construction, design, fabrication, tests, rating, and installation in compliance with the regulations of all local, state or national agencies having jurisdiction over the project. Pay all costs involved in work necessary to comply with these regulations.
- E. The Contractor assumes all responsibility and liability for any code violations, damage or injury which occurs as a result of deviation from or a change to the requirements of these plans and specifications which has not been approved in writing by the Engineer.

1.9 SUBMITTAL OF SHOP DRAWINGS FOR REVIEW:

- A. Submit Shop Drawings in accordance with SUBMITTALS Division 1 and as indicated in subsequent Sections of this Division. Assume responsibility for quantities and correct mounting details. In addition, submit other shop drawings as may be requested by the Architect.
 - 1. Metal Clad Cable
 - 2. Building Wire
 - 3. Conduit
 - 4. Fittings
 - 5. Wireways
 - 6. Outlet Boxes
 - 7. Floor Boxes
 - 8. Switches
 - 9. Receptacles
 - 10. Wall Plates
 - 11. Occupancy Sensors
 - 12. Dimmer Switches
 - 13. Panelboards
 - 14. Safety Switches
 - 15. Circuit Breakers
 - 16. Switchboards
 - 17. Lighting Fixtures
 - 18. Fire Alarm & Detection System Equipment

1.10 DRAWINGS:

- A. The Electrical drawings are indicative of the general arrangements and approximate sizes and relative locations of principal materials to be provided. Drawings are diagrammatic and are a graphic representation of contract requirements to best available standards at the scale required. Provide certain items such as pull boxes, offsets to clear interferences, and supports which are not specifically shown but which are obviously needed to make the system complete and operable.
- B. Verify all grades, elevations, dimensions and clearances at the site.
- C. Electrical riser and schematic diagrams generally indicate wiring to be used in various systems. Provide all work shown on diagrams whether or not it is duplicated on the plans.
- D. All drawings and specifications pertaining to general construction, plumbing, HVAC, kitchen, electrical and other work shall be carefully examined. Where physical interferences with his work occur because of his failure to coordinate with other trades, this Contractor shall rearrange his work at his own expense.

1.11 ENVIRONMENTAL CONDITIONS:

- A. Provide effective protection for all material and equipment against damage that may be caused by environmental conditions. Do no work when conditions or temperature in area or moisture on materials or substrates are not in accordance with material manufacturer's recommended conditions for installation.

1.12 PROTECTION:

- A. Provide effective protection against damage for all materials and equipment during shipment, and storage at the Project site. Cover all stored equipment to exclude dust and moisture. Place stored conduit on dunnage with appropriate weather cover and caps on exposed ends.
- B. After cabinets and boxes are installed, cover openings to prevent entrance of water and foreign materials. Close conduit openings with temporary metal or plastic caps, including those terminated in cabinets.
- C. Protect all rough and finished floors and finished surfaces from damage which may be caused by construction materials and methods. Protect floors with tarpaulins, chip pans and oil-proof floor coverings. Protect finished surfaces from welding and cutting splatters with baffles and asbestos splatter blankets. Protect finished surfaces from paint droppings, adhesive and other marring agents with drop cloths. Protect other surfaces with appropriate protective measures.

1.13 PRODUCT:

- A. Have materials delivered to site. Unload and store materials in allotted location, and protect from damage. Deliver materials to their point of installation.
- B. Deliver materials to Project site in manufacturer's original unopened containers with manufacturer's name and product identification clearly marked thereon.

1.14 COMPLIANCE WITH GENERAL STANDARDS AND REGULATIONS:

- A. Provide equipment that is in conformity with these specifications and applicable requirements of the following:
 - 1. AASHTO American Assoc. of State Highway and Transportation Officials
 - 2. ACI American Concrete Institute
 - 3. AISC American Institute of Steel Construction
 - 4. AISI American Iron and Steel Institute
 - 5. ANSI American National Standards Institute
 - 6. ASTM American Society for Testing and Materials
 - 7. AWS American Welding Society
 - 8. CBM Certified Ballast Manufacturers Assoc.
 - 9. CRSI Concrete Reinforcing Steel Institute
 - 10. EIA Electronic Industries Assoc.
 - 11. ETL ETL Testing Laboratories Inc.
 - 12. FM Factory Mutual Research Assoc.
 - 13. ICE AInsulated Cable Engineers Association, Inc.
 - 14. IEC Internatioinal Electrotechnical Commission
 - 15. IEE EInstitute of Electrical and Electronic Engineers
 - 16. IESNA Illuminating Engineering Society of North America
 - 17. IMS AInternational Municipal Signal Association
 - 18. LPI Lighting Protection Institute
 - 19. NEC National Electric Code
 - 20. NECA National Electrical Contractors Association
 - 21. NEMA National Electrical Manufacturers Association
 - 22. NETA International Electrical Testing Association
 - 23. NFPA National Fire Protection Association
 - 24. UL Underwriters Laboratories, Inc

1.15 COMPLIANCE WITH FEDERAL GOVERNMENT AGENCIES

- A. Names and titles of federal government standard - or Specification-producing agencies are often abbreviated. The following acronyms or abbreviations referenced in the Contract Documents indicate names of standard - Specification-producing agencies of the federal government. Names and addresses are subject to change but are believed to be, but are not assured to be, accurate and up to the date of the Contract Documents.

1. ADAAmericans With Disabilities Act
2. CFRCode of Federal Regulations
3. EPAEnvironmental Protection Agency
4. FAAFederal Aviation Administration (US Dept. of Transportation)
5. FCCFederal Communication Commission
6. FSFederal Specification (from GSA); Specifications Unit (WFISIS)
7. MILMilitary Standardization Documents (US Department of Defence) Naval Publications and Forms Center
8. OSHAOccupational Safety and Health Administration (US Department of Labor)
9. REARural Electrification Administration (US Department of Agriculture)

1.16 GUARANTEE:

- A. Each Contractor shall unconditionally guarantee in writing all materials, equipment, and workmanship for a period of one year from date of acceptance by Owner. The Contractor shall provide free service for all equipment involved in his Contract during this guarantee period.
- B. The guarantee shall include restoration to its original condition of all adjacent work that must be disturbed in fulfilling this guarantee.
- C. All such repairs and/or replacements shall be made without delay and at the convenience of the Owner.

PART 2 - PRODUCTS

2.1 REFER TO DIVISION 26 - ELECTRICAL

PART 3 - EXECUTION

3.1 LOCATION OF MATERIAL:

- A. Locate all lighting fixtures, power apparatus, conduit, outlets and other materials to result in proper operation of the building and to avoid conflicts with the work of other trades. Obtain required location information sufficiently in advance of installation time to allow uninterrupted progress of the work. Check layouts of equipment with shop drawings of all trades to determine roughing-in requirements. Do not scale drawings for exact locations. Exercise proper judgment to secure a neat arrangement of conduit, piping, ductwork and other material; and to overcome local interferences to best advantage of the Project.

- B. Where physical interferences cannot be resolved readily, consult with the Construction Manager and Architect and prepare dated, dimensioned drawings correcting the interferences. Obtain written approval of the Construction Manager and Architect for such changes and distribute the drawings to all interested parties as directed by the Construction Manager and Architect.
- C. In modular panel ceilings, locate lights, detectors and similar equipment as shown on reflected ceiling plan. Arrange ceiling outlets symmetrically. Verify locations of all floor outlets with Architect before roughing-in.
- D. Locate switches and other manually operated devices in a location easily accessible and convenient to operating personnel. If any such devices are mounted in a location deemed inaccessible or impractical, relocate devices at no increase in contract costs.

3.2 EARTHWORK:

- A. Provide all excavation, backfill, shoring and similar work as required for the installation of the Work of this Division. Refer to the requirements of Excavation, Grading and Site Work, Section 33, and Earthwork, Division 2.
- B. Protect roots of live trees encountered in excavation.
- C. Where excavations at footings, foundations, and other structures are deeper than the angle of repose deemed adequate by Architect, backfill such excavations solidly with 3000 pound concrete.
- D. Remove and dispose of excess excavated materials as directed by the Construction Manager or Architect.

3.3 FLASHING AND COUNTERFLASHING:

- A. Provide metal flashing and counterflashing under Division 26 in accordance with SHEET METAL, Division 7, for all conduits penetrating the roof. Form counterflashing into a rainhood attached to conduit and passed down over top of flashing. Attach counterflashing to conduit with clamp, and waterproof with sealing compound.
- B. Base flashing will be worked into roofing.

3.4 CHASES AND OPENINGS:

- A. Openings, recesses and chases will be provided in the building construction as described in SUPPLEMENTAL GENERAL CONDITIONS. Make detailed dimensioned drawings under Division 26 where required by Architect.

3.5 CUTTING AND PATCHING:

- A. Perform all cutting of existing building construction under Division 26 as required for installation of electrical work.
- B. Perform cutting carefully so as not to damage the structure or leave unsightly surfaces that cannot be covered with plates, escutcheons, or other normal concealing construction. Patch unsightly conditions resulting from cutting as directed by the Construction Manager or Architect. Engage competent mechanics for patching.

3.6 CONCRETE:

- A. Provide all concrete required for the work of Division 26 - ELECTRICAL, unless otherwise noted. Provide 3000 pound concrete in accordance with the provisions of Division- CONCRETE.
- B. Provide concrete housing cleaning pads for all freestanding electrical equipment inside and site light bases outside building, unless otherwise noted. Include all required anchor bolts, fish plates, sleeves, inserts, conduit and miscellaneous hardware and have them installed in their proper location in all concrete foundations.

3.7 MOTOR STARTERS

- A. Furnish all manual motor starters, and mount where shown on drawings.
- B. Mount manual motor starters for roof fans in an accessible location inside the building to avoid affecting thermal devices by atmospheric conditions.
- C. In general, magnetic motor starters will be delivered to the site with the equipment they control.
 - 1. Starters furnished under Division 21, 22, and 23 will be delivered to the Electrical Contractor for installation and wiring. The Electrical Contractor shall mount the starters where shown on the Drawings, and provide power wiring to the starter, as well as power wiring from the starter to the motor. Control wiring will be provided under the HVAC Contract.
 - 2. Equipment furnished under other Divisions and under other contracts generally will not be combination type. Provide disconnects as required by the NEC within site of the controller and motor.
 - 3. Check running current of each motor and verify correct size of overload elements, and fuses in combination starters. Notify Architect in writing of all overload elements and fuses incorrectly sized, so that corrective action can be initiated.
 - 4. Prepare a typewritten list of all motors in the project, and submit to Architect for delivery to the Owner. Include the following information for each motor:
 - a. Function and nomenclature, as identified by the marking actually used in the field.

- b. Physical location in the building.
- c. Rated horsepower, voltage and phase.
- d. Rated full load current.
- e. Proper size of thermal overload element.
- f. Mount all motor starters, except those factory mounted on equipment.

3.8 COLOR CODING OF WIRING

- A. Color code all wiring in accordance with the following table. In general, use factory colored insulation. Use colored vinyl tape for black insulation on cables No. 8 and larger. Apply pressure sensitive tape in half-lap serving for distance of 6" at cable terminations, in pull boxes, manholes, panels, and similar locations.

1. Phase	208/120 Volts	480/277 Volts
2. Phase "A"	Black	Brown
3. Phase "B"	Blue	Orange
4. Phase "C"	Red	Yellow
5. Neutral	White	Gray
6. Equipment ground	Green	Green

3.9 PHASING

- A. Phase building load centers and panelboards "A", "B", "C" top to bottom and left to right. Identify the neutral, although it may be in different locations for different equipment.
- B. Connect transformers in all systems so that:
- 1. "A" Phase is terminated at "H1" connection.
 - 2. "B" Phase is terminated at "H2" connection.
 - 3. "C" Phase is terminated at "H3" connection.
 - 4. "X1" connection shall be the "A" Phase.
 - 5. "X2" connection shall be the "B" Phase.
 - 6. "X3" connection shall be the "C" Phase.
- C. Ascertain from Power Company phase identifications at the point of connection and thereafter carry out and maintain this consistent system of color coding, phase identification and positioning.
- D. Verify phase rotation after all terminations at equipment have been made, by producing a 1-2-3 rotation on a phase sequence meter when connected to "A", "B", and "C" phases. Make phase rotation compatible with existing distribution system.

3.10 GROUNDING RESISTANCE TEST:

- A. Provide grounding system resistance test to verify resistance. Maximum resistance shall be 5 ohms.

- B. Send final certified test reports and Certifications to Construction Manager for approval and transmittal to the Owner in accordance with SUBMITTALS, Division 1.

3.11 INSPECTION AND CERTIFICATION:

- A. Obtain and deliver a final Certificate of Approval from the applicable NEC inspection authority having jurisdiction. Make delivery to Construction Manager for transmittal to the Owner upon completion of the work and before final payment in accordance with PROJECT CLOSE-OUT, Division 1. Pay all charges made by the inspection authority and include their cost in the bid.

3.12 INSTALLATION:

- A. Install equipment in accordance with manufacturer's recommendations.

3.13 EQUIPMENT BY OWNER:

- A. The Owner will furnish certain equipment, and deliver this equipment to the site as stated in EQUIPMENT FURNISHED BY OWNER, Division 11. Provide final electrical connections as required.

3.14 AS-BUILT DRAWINGS:

- A. During construction, the Contractor shall maintain a record set of installation prints. He shall record on these prints, all deviations from the Contract Drawings in pipe sizing, location, and details. The record set of installation prints shall be updated at the end of each month and shall be delivered to the Construction Manager and the Architect.
- B. At the completion of the work, the Contractor shall forward these prints to the Construction Manager and the Architect for incorporation into the final As-Built Drawings.

3.15 INSTRUCTION TO EMPLOYEES:

- A. At the completion of the work, and before final acceptance of the building by the Owner, each Contractor, together with the representatives of the manufacturers of the equipment installed by the Contractor, shall instruct the designated employees of the Owner in the care, adjustment, maintenance and operation of equipment installed by him.
- B. Three copies of factory maintenance schedules shall be furnished for each of equipment. Acceptance of materials and equipment is conditional upon receipts of maintenance manuals.

- C. A representative of the manufacturer of each piece of equipment shall inspect his respective pieces of equipment, make final adjustments, and put them in a satisfactory working condition.
- D. Instructions described shall be given for the following systems:
 - 1. Fire Alarm & Detection System.
 - 2. Emergency Generator System

END OF SECTION 260100

SECTION 260501 - MINOR ELECTRICAL DEMOLITION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical demolition.

1.2 RELATED REQUIREMENTS

- A. Section 01 7000 – Execution and Closeout Requirements: Additional requirements for alterations work.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work. As specified in individual sections.

PART 3 EXECUTION

3.1 EXAMINATION

- A. The Contractor shall obtain and familiarize himself with early-bid contract documents and early phasing work outside of this contract to ensure full coordination of work between this contract and existing/previously awarded contract phases.
- B. Change orders will not be considered for failure of the contractor to visit the site and/or coordinate with the work of other trades.
- C. Verify that abandoned wiring and equipment serve only abandoned facilities.
- D. Demolition drawings are based on casual field observation and existing record documents.
- E. Report discrepancies to Architect before disturbing existing installation.
- F. Beginning of demolition means installer accepts existing conditions.
- G. Reroute any existing conduits, wiring in conflict with new work.

- H. All existing devices to remain, shall remain in operational condition. Reconnect any devices, equipment, lighting, etc. which is to remain, but must be disconnected for installation of new work. This includes but is not limited to existing loads disconnected from demolished electrical panels and must be extended to new electrical panels.

3.2 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. Coordinate utility service outages with Utility Company.
- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Obtain permission from Owner at least 24 hours before partially or completely disabling system.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Remove, relocate, and extend existing installations to accommodate new construction.
- B. Remove abandoned wiring to source of supply.
- C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floor, and patch surfaces.
- D. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- E. Disconnect and remove abandoned panelboards and distribution equipment.
- F. Disconnect and remove electrical devices and equipment serving utilization equipment has been removed.
- G. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- H. Repair adjacent construction and finishes damaged during demolition and extension work.

- I. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- J. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

3.4 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment that remain or that are to be reused.
- B. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.

END OF SECTION 260501

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SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Single conductor building wire.
- B. Underground feeder and branch-circuit cable.
- C. Armored cable.
- D. Metal-clad cable.
- E. Variable-frequency drive cable.
- F. Wiring connectors.
- G. Electrical tape.
- H. Heat shrink tubing.
- I. Oxide inhibiting compound.
- J. Wire pulling lubricant.
- K. Cable ties.
- L. Firestop sleeves.

1.2 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping.
- B. Section 260526 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
- C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

- A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013 (Reapproved 2018).
- B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011 (Reapproved 2017).
- C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010, with Editorial Revision (2020).
- D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2020).
- E. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2017.
- F. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes; 2020.
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2022.
- H. FM 3971 - Fire Protective Coatings and Wraps for Grouped Cables; 2019.
- I. IEEE 383 - IEEE Standard for Qualifying Electric Cables and Splices for Nuclear Facilities; 2015.
- J. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- K. NECA 120 - Standard for Installing Armored Cable (AC) and Type Metal-Clad (MC) Cable; 2018.
- L. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; 2021.
- M. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems; 2021.
- N. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- O. NFPA 79 - Electrical Standard for Industrial Machinery; 2021.
- P. UL 4 - Armored Cable; Current Edition, Including All Revisions.

- Q. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.
- R. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.
- S. UL 267 - Outline of Investigation for Wire-Pulling Compounds; Most Recent Edition, Including All Revisions.
- T. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.
- U. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.
- V. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.
- W. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.
- X. UL 1569 - Metal-Clad Cables; Current Edition, Including All Revisions.
- Y. UL 2277 - Outline of Investigation for Flexible Motor Supply Cable and Wind Turbine Tray Cable; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
 - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
- C. Field Quality Control Test Reports.

- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.8 FIELD CONDITIONS

- A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.1 CONDUCTOR AND CABLE APPLICATIONS

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.

- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- C. Nonmetallic-sheathed cable is not permitted.
- D. Underground feeder and branch-circuit cable is not permitted.
- E. Service entrance cable is not permitted.
- F. Armored cable is permitted only as follows:
 - 1. Where not otherwise restricted, may be used:
 - a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.
 - 1) Maximum Length: 6 feet.
- G. Metal-clad cable is permitted only as follows:
 - 1. Where not otherwise restricted, may be used:
 - a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.
 - 1) Maximum Length: 6 feet.
 - b. Where concealed in hollow stud walls, above accessible ceilings, and under raised floors for branch circuits up to 20 A.
 - 1) Exception: Provide single conductor building wire in raceway for circuit homerun from first outlet to panelboard.
 - 2. In addition to other applicable restrictions, may not be used:
 - a. Where exposed to damage.
 - b. For damp, wet, or corrosive locations, unless provided with a PVC jacket listed as suitable for those locations.
 - c. For isolated ground circuits, unless provided with an additional isolated/insulated grounding conductor.
- H. Manufactured wiring systems are not permitted.

2.2 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- D. Comply with NEMA WC 70.

- E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- G. Conductors for Grounding and Bonding: Also comply with Section 260526.
- H. Conductors and Cables Installed in Cable Tray: Listed and labeled as suitable for cable tray use.
- I. Conductors and Cables Installed Where Exposed to Direct Rays of Sun: Listed and labeled as sunlight resistant.
- J. Conductors and Cables Installed Exposed in Spaces Used for Environmental Air (only where specifically permitted): Plenum rated, listed and labeled as suitable for use in return air plenums.
- K. Conductor Material:
 - 1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
 - 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
 - 3. Tinned Copper Conductors: Comply with ASTM B33.
- L. Minimum Conductor Size:
 - 1. Branch Circuits: 12 AWG.
 - a. Exceptions:
 - 1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
 - 2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
 - 3) 20 A, 277 V circuits longer than 150 feet: 10 AWG, for voltage drop.
 - 2. Control Circuits: 14 AWG.
- M. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- N. Conductor Color Coding:
 - 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
 - 2. Color Coding Method: Integrally colored insulation.
 - a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
 - 3. Color Code:
 - a. 480Y/277 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.

- 3) Phase C: Yellow.
- 4) Neutral/Grounded: Gray.
- b. 208Y/120 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral/Grounded: White.
- c. Equipment Ground, All Systems: Green.
- d. Isolated Ground, All Systems: Green with yellow stripe.
- e. Travelers for 3-Way and 4-Way Switching: Pink.
- f. For modifications or additions to existing wiring systems, comply with existing color code when existing code complies with NFPA 70 and is approved by the authority having jurisdiction.
- g. For control circuits, comply with manufacturer's recommended color code.

2.3 SINGLE CONDUCTOR BUILDING WIRE

- A. Manufacturers:
 - 1. Copper Building Wire:
 - a. Cerro Wire LLC: www.cerrowire.com/#sle.
 - b. Encore Wire Corporation: www.encorewire.com/#sle.
 - c. General Cable Technologies Corporation; _____: www.generalcable.com/#sle.
 - d. Service Wire Co: www.servicewire.com/#sle.
 - e. Southwire Company: www.southwire.com/#sle.
 - f. Substitutions: See Section 016000 - Product Requirements.
- B. Description: Single conductor insulated wire.
- C. Conductor Stranding:
 - 1. Feeders and Branch Circuits:
 - a. Size 10 AWG and Smaller: Solid.
 - b. Size 8 AWG and Larger: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation:
 - 1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
 - a. Size 4 AWG and Larger: Type XHHW-2.
 - b. Installed Underground: Type XHHW-2.

2.4 ARMORED CABLE

- A. Manufacturers:

1. AFC Cable Systems Inc: www.afcweb.com/#sle.
 2. Encore Wire Corporation: www.encorewire.com/#sle.
 3. Southwire Company: www.southwire.com/#sle.
 4. Substitutions: See Section 016000 - Product Requirements.
- B. Description: NFPA 70, Type AC cable listed and labeled as complying with UL 4, and listed for use in classified firestop systems to be used.
- C. Conductor Stranding:
1. Size 10 AWG and Smaller: Solid.
 2. Size 8 AWG and Larger: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation: Type THHN.
- F. Grounding: Combination of interlocking armor and integral bonding wire.
- G. Armor: Steel, interlocked tape.

2.5 METAL-CLAD CABLE

- A. Manufacturers:
1. AFC Cable Systems Inc: www.afcweb.com/#sle.
 2. Encore Wire Corporation: www.encorewire.com/#sle.
 3. Service Wire Co: www.servicewire.com/#sle.
 4. Southwire Company: www.southwire.com/#sle.
 5. Substitutions: See Section 016000 - Product Requirements.
- B. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.
- C. Conductor Stranding:
1. Size 10 AWG and Smaller: Solid.
 2. Size 8 AWG and Larger: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation: Type THHN/THWN-2.
- F. Grounding: Full-size integral equipment grounding conductor.
- G. Armor: Steel, interlocked tape.

- H. Provide PVC jacket applied over cable armor where indicated or required for environment of installed location.

2.6 VARIABLE-FREQUENCY DRIVE CABLE

- A. Manufacturers:
 - 1. Service Wire Co; ServiceDrive: www.servicewire.com/#sle.
 - 2. Substitutions: See Section 016000 - Product Requirements.
- B. Description: Flexible motor supply cable listed and labeled as complying with UL 2277 in accordance with NFPA 79; specifically designed for use with variable frequency drives and associated nonlinear power distortions.
- C. Conductor Stranding: Stranded.
- D. Insulation Voltage Rating: 1000 V.
- E. Insulation: Use only thermoset insulation types; thermoplastic insulation types are not permitted.
- F. Grounding: Full-size integral equipment grounding conductor or symmetrical arrangement of multiple conductors of equivalent size.
- G. Provide metallic shielding.
- H. Jacket: PVC or Chlorinated Polyethylene (CPE).

2.7 WIRING CONNECTORS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- B. Connectors for Grounding and Bonding: Comply with Section 260526.
- C. Wiring Connectors for Splices and Taps:
 - 1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
 - 2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.
- D. Wiring Connectors for Terminations:
 - 1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.

2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
 3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
 4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
 5. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors where connectors are required.
- E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.
- F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.
- G. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. Ideal Industries, Inc: www.idealindustries.com/#sle.
 - c. NSI Industries LLC: www.nsiindustries.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- H. Mechanical Connectors: Provide bolted type or set-screw type.
1. Manufacturers:
 - a. Burndy LLC; _____: www.burndy.com/#sle.
 - b. IlSCO: www.ilSCO.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- I. Compression Connectors: Provide circumferential type or hex type crimp configuration.
1. Manufacturers:
 - a. Burndy LLC; _____: www.burndy.com/#sle.
 - b. IlSCO: www.ilSCO.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.

2.8 ACCESSORIES

- A. Electrical Tape:
1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. Plymouth Rubber Europa: www.plymouthrubber.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.

2. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
 3. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
 4. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.
 5. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.
 6. Varnished Cambric Electrical Tape: Cotton cambric fabric tape, with or without adhesive, oil-primed and coated with high-grade insulating varnish; minimum thickness of 7 mil; suitable for continuous temperature environment up to 221 degrees F.
 7. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.
- B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. Burndy LLC; _____: www.burndy.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- C. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.
1. Manufacturers:
 - a. Burndy LLC; _____: www.burndy.com/#sle.
 - b. Ideal Industries, Inc: www.idealindustries.com/#sle.
 - c. IlSCO: www.ilsco.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- D. Wire Pulling Lubricant:
1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. American Polywater Corporation: www.polywater.com/#sle.
 - c. Ideal Industries, Inc: www.idealindustries.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
 2. Listed and labeled as complying with UL 267.
 3. Suitable for use with conductors/cables and associated insulation/jackets to be installed.
 4. Suitable for use at installation temperature.
 5. Products:

- a. American Polywater Corporation; Polywater J Cable Pulling Lubricant: www.polywater.com/#sle.
 - b. American Polywater Corporation; Polywater LZ Cable Pulling Lubricant: www.polywater.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.
- E. Cable Ties: Material and tensile strength rating suitable for application.
- F. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for cables and roofing system to be installed; designed to accommodate existing penetrations where applicable.
- 1. Products:
 - a. Menzies Metal Products; Electrical Roof Stack and Cap: www.menzies-metal.com/#sle.
 - b. Menzies Metal Products; Electrical Retro Box: www.menzies-metal.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.
- G. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.
- 1. Products:
 - a. HoldRite, a brand of Reliance Worldwide Corporation; HydroFlame Pro Series/HydroFlame Custom Built: www.holdrite.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- H. Fire-Protective Coating for Electrical Conductors and Cables: Field-applied, intumescent or ablative coating designed to prevent ignition and propagation of fire along thermoplastic-insulated conductors and cables.
- 1. Pass flammability tests of one of the following:
 - a. ASTM E84, Class A; maximum flame spread index of 25.
 - b. FM 3971.
 - c. IEEE 383.
 - 2. Products:
 - a. Vimasco Corporation; CharCoat CC Cable Coating: www.charcoat.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.

- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that field measurements are as indicated.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.3 INSTALLATION

- A. Circuiting Requirements:
 - 1. Unless dimensioned, circuit routing indicated is diagrammatic.
 - 2. When circuit destination is indicated without specific routing, determine exact routing required.
 - 3. Arrange circuiting to minimize splices.
 - 4. Include circuit lengths required to install connected devices within 10 ft of location indicated.
 - 5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
 - 6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
 - 7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is permitted, under the following conditions:
 - a. Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.
 - b. Increase size of conductors as required to account for ampacity derating.
 - c. Size raceways, boxes, etc. to accommodate conductors.
 - 8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
 - 9. Provide oversized neutral/grounded conductors where indicated and as specified below.
 - a. Provide 200 percent rated neutral for feeders fed from K-rated transformers.
 - b. Provide 200 percent rated neutral for feeders serving panelboards with 200 percent rated neutral bus.
- B. Install products in accordance with manufacturer's instructions.
- C. Perform work in accordance with NECA 1 (general workmanship).

- D. Install armored cable (Type AC) in accordance with NECA 120.
- E. Install metal-clad cable (Type MC) in accordance with NECA 120.
- F. Installation in Raceway:
 - 1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
 - 2. Pull all conductors and cables together into raceway at same time.
 - 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
 - 4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- G. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- H. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
 - 1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.
 - 2. Installation in Vertical Raceways: Provide supports where vertical rise exceeds permissible limits.
- I. Terminate cables using suitable fittings.
 - 1. Armored Cable (Type AC):
 - a. Use listed fittings and anti-short, insulating bushings.
 - b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
 - 2. Metal-Clad Cable (Type MC):
 - a. Use listed fittings.
 - b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
- J. Variable-Frequency Drive Cable: Terminate shielding at both variable-frequency motor controller and associated motor using glands or termination kits recommended by manufacturer.
- K. Install conductors with a minimum of 12 inches of slack at each outlet.
- L. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- M. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.

- N. Make wiring connections using specified wiring connectors.
1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
 3. Do not remove conductor strands to facilitate insertion into connector.
 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminants. Do not use wire brush on plated connector surfaces.
 5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- O. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
 - b. For taped connections likely to require re-entering, including motor leads, first apply varnished cambric electrical tape, followed by adequate amount of rubber splicing electrical tape, followed by outer covering of vinyl insulating electrical tape.
 2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
 - b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
 3. Wet Locations: Use heat shrink tubing.
- P. Insulate ends of spare conductors using vinyl insulating electrical tape.
- Q. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.
- R. Identify conductors and cables in accordance with Section 260553.
- S. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.

- T. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.4 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
 - 1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.
- D. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.
- D. Ground bars.
- E. Ground rod electrodes.
- F. Ground enhancement material.
- G. Ground access wells.

1.2 RELATED REQUIREMENTS

- A. Section 134613 - Lightning Protection for Structures.
- B. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
 - 1. Includes oxide inhibiting compound.
- C. Section 260536 - Cable Trays for Electrical Systems: Additional grounding and bonding requirements for cable tray systems.
- D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 265600 - Exterior Lighting: Additional grounding and bonding requirements for pole-mounted luminaires.

1.3 REFERENCE STANDARDS

- A. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System; 2012.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

- C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; 2017.
- D. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems; 2021.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. NFPA 99 - Health Care Facilities Code; 2021, with Amendment.
- G. NFPA 780 - Standard for the Installation of Lightning Protection Systems; 2023.
- H. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.
- C. Field quality control test reports.

1.5 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.1 GROUNDING AND BONDING REQUIREMENTS

- A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.
- B. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

E. Grounding System Resistance:

1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.
2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.
3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.

F. Grounding Electrode System:

1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
 - a. Provide continuous grounding electrode conductors without splice or joint.
 - b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
2. Metal Underground Water Pipe(s):
 - a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
 - b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
 - c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
3. Metal In-Ground Support Structure:
 - a. Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with NFPA 70.
4. Concrete-Encased Electrode:
 - a. Provide connection to concrete-encased electrode consisting of not less than 20 feet of either steel reinforcing bars or bare copper conductor not smaller than 4 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.
5. Ground Rod Electrode(s):
 - a. Provide three electrodes in an equilateral triangle configuration unless otherwise indicated or required.
 - b. Space electrodes not less than 20 feet from each other and any other ground electrode.
 - c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
 - d. Provide ground enhancement material around electrode.
 - e. Provide ground access well for each electrode.
6. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.

7. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
 - a. Ground Bar Size: 1/4 by 4 by 12 inches unless otherwise indicated or required.
 - b. Where ground bar location is not indicated, locate in accessible location as near as possible to service disconnect enclosure.
 - c. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.
8. Ground Riser: Provide common grounding electrode conductor not less than 3/0 AWG for tap connections to multiple separately derived systems as permitted in NFPA 70.

G. Service-Supplied System Grounding:

1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.

H. Grounding for Separate Building or Structure Supplied by Feeder(s) or Branch Circuits:

1. Provide grounding electrode system for each separate building or structure.
2. Provide equipment grounding conductor routed with supply conductors.
3. For each disconnecting means, provide grounding electrode conductor to connect equipment ground bus to grounding electrode system.
4. Do not make any connections and remove any factory-installed jumpers between neutral (grounded) conductors and ground.

I. Separately Derived System Grounding:

1. Separately derived systems include, but are not limited to:
 - a. Transformers (except autotransformers such as buck-boost transformers).
 - b. Uninterruptible power supplies (UPS), when configured as separately derived systems.
 - c. Generators, when neutral is switched in the transfer switch.
2. Provide grounding electrode conductor to connect derived system grounded conductor to common grounding electrode conductor ground riser. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.
3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.

4. Where common grounding electrode conductor ground riser is used for tap connections to multiple separately derived systems, provide bonding jumper to connect the metal building frame and metal water piping in the area served by the derived system to the common grounding electrode conductor.
 5. Outdoor Source: Where the source of the separately derived system is located outside the building or structure supplied, provide connection to grounding electrode at source in accordance with NFPA 70.
 6. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.
 7. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.
- J. Bonding and Equipment Grounding:
1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
 2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
 3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
 4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
 5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
 6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
 7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
 - a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
 - b. Metal gas piping.
 - c. Metal process piping.
 8. Provide bonding for interior metal air ducts.
 9. Provide bonding for metal building frame.
 10. Provide bonding for metal siding not effectively bonded through attachment to metal building frame.
 11. Provide bonding and equipment grounding for pools and fountains and associated equipment in accordance with NFPA 70.
 12. Provide redundant grounding and bonding for patient care areas of health care facilities in accordance with NFPA 70 and NFPA 99.

K. Isolated Ground System:

1. Where isolated ground receptacles or other isolated ground connections are indicated, provide separate isolated/insulated equipment grounding conductors.
2. Connect isolated/insulated equipment grounding conductors only to separate isolated/insulated equipment ground busses.
3. Connect the isolated/insulated equipment grounding conductors to the solidly bonded equipment ground bus only at the service disconnect or separately derived system disconnect. Do not make any other connections between isolated ground system and normal equipment ground system on the load side of this connection.

L. Communications Systems Grounding and Bonding:

1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with NFPA 70.
2. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.
 - a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.
 - b. Raceway Size: 3/4 inch trade size unless otherwise indicated or required.
 - c. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
 - d. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.

M. Lightning Protection Systems:

1. See Section 134613 for additional requirements.
2. Do not use grounding electrode dedicated for lightning protection system for component of building grounding electrode system provided under this section.
3. Provide bonding of building grounding electrode system provided under this section and lightning protection grounding electrode system in accordance with NFPA 70 and NFPA 780.

N. Cable Tray Systems: Also comply with Section 260536.

O. Pole-Mounted Luminaires: Also comply with Section 265600.

2.2 GROUNDING AND BONDING COMPONENTS

A. General Requirements:

1. Provide products listed, classified, and labeled as suitable for the purpose intended.
2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 260526:

1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:
 - 1) Use bare copper conductors where installed underground in direct contact with earth.
 - 2) Use bare copper conductors where directly encased in concrete (not in raceway).

C. Connectors for Grounding and Bonding:

1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
3. Unless otherwise indicated, use mechanical connectors or exothermic welded connections for accessible connections.
4. Manufacturers - Mechanical and Compression Connectors:
 - a. allG Fabrication; _____: www.allgfab.com/#sle.
 - b. Burndy LLC; _____: www.burndy.com/#sle.
 - c. Harger Lightning & Grounding; _____: www.harger.com/#sle.
 - d. nVent ERICO; _____: www.nvent.com/#sle.
 - e. Thomas & Betts Corporation; _____: www.tnb.com/#sle.
 - f. Substitutions: See Section 016000 - Product Requirements.
5. Manufacturers - Exothermic Welded Connections:
 - a. Burndy LLC; _____: www.burndy.com/#sle.
 - b. nVent ERICO; Cadweld: www.nvent.com/#sle.
 - c. thermOweld, subsidiary of Continental Industries; division of Burndy LLC; _____: www.thermoweld.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.

D. Ground Bars:

1. Description: Copper rectangular ground bars with mounting brackets and insulators.
2. Size: As indicated.
3. Holes for Connections: As indicated or as required for connections to be made.
4. Manufacturers:
 - a. allG Fabrication; _____: www.allgfab.com/#sle.
 - b. Harger Lightning & Grounding; _____: www.harger.com/#sle.
 - c. nVent ERICO; _____: www.nvent.com/#sle.
 - d. thermOweld, subsidiary of Continental Industries; division of Burndy LLC; _____: www.thermoweld.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.

E. Ground Rod Electrodes:

1. Comply with NEMA GR 1.
2. Material: Copper-bonded (copper-clad) steel.
3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.
4. Manufacturers:
 - a. allG Fabrication; _____: www.allgfab.com/#sle.
 - b. Galvan Industries, Inc; _____: www.galvanelectrical.com/#sle.
 - c. Harger Lightning & Grounding; _____: www.harger.com/#sle.
 - d. nVent ERICO; _____: www.nvent.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.

F. Ground Enhancement Material:

1. Description: Factory-mixed conductive material designed for permanent and maintenance-free improvement of grounding effectiveness by lowering resistivity.

2. Resistivity: Not more than 20 ohm-cm in final installed form.
3. Manufacturers:
 - a. Harger Lightning & Grounding; _____: www.harger.com/#sle.
 - b. nVent ERICO; GEM: www.nvent.com/#sle.
 - c. thermOweld, subsidiary of Continental Industries; division of Burndy LLC; _____: www.thermoweld.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.

G. Ground Access Wells:

1. Description: Open bottom round or rectangular well with access cover for testing and inspection; suitable for the expected load at the installed location.
2. Size: As required to provide adequate access for testing and inspection, but not less than minimum size requirements specified.
 - a. Round Wells: Not less than 8 inches in diameter.
 - b. Rectangular Wells: Not less than 12 by 12 inches.
3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 10 inches.
4. Cover: Factory-identified by permanent means with word "GROUND".
5. Manufacturers:
 - a. allG Fabrication; _____: www.allgfab.com/#sle.
 - b. Harger Lightning & Grounding; _____: www.harger.com/#sle.
 - c. nVent ERICO; _____: www.nvent.com/#sle.
 - d. thermOweld, subsidiary of Continental Industries; division of Burndy LLC; _____: www.thermoweld.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.

H. Oxide Inhibiting Compound: Comply with Section 260519.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as indicated.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).

- C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.
 - 1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
 - 2. Indoor Installations: Unless otherwise indicated, install with 4 inches of top of rod exposed.
- D. Make grounding and bonding connections using specified connectors.
 - 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 - 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 - 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
 - 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 - 5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- E. Identify grounding and bonding system components in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.13.
- D. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
- E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.
- F. Submit detailed reports indicating inspection and testing results and corrective actions taken.

END OF SECTION 260526

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SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 055000 - Metal Fabrications: Materials and requirements for fabricated metal supports.

1.3 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2019.
- D. MFMA-4 - Metal Framing Standards Publication; 2004.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 5B - Strut-Type Channel Raceways and Fittings; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with actual equipment and components to be installed.
 - 2. Coordinate work to provide additional framing and materials required for installation.

3. Coordinate compatibility of support and attachment components with mounting surfaces at installed locations.
4. Coordinate arrangement of supports with ductwork, piping, equipment and other potential conflicts.
5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has cured; see Section 033000.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel/strut framing systems, nonpenetrating rooftop supports, and post-installed concrete/masonry anchors.

1.6 QUALITY ASSURANCE

- A. Maintain at project site one copy of each referenced document that prescribes execution requirements.
- B. Installer Qualifications for Field Welding: See Section 055000.
- C. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:

1. Comply with the following. Where requirements differ, comply with most stringent.
 - a. NFPA 70.
 - b. Requirements of authorities having jurisdiction.
2. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of electrical work.

3. Provide products listed, classified, and labeled as suitable for purpose intended, where applicable.
 4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for load to be supported with minimum safety factor of 2. Include consideration for vibration, equipment operation, and shock loads where applicable.
 5. Do not use products for applications other than as permitted by NFPA 70 and product listing.
 6. Steel Components: Use corrosion-resistant materials suitable for environment where installed.
 - a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit and Cable Supports: Straps and clamps suitable for conduit or cable to be supported.
1. Manufacturers:
 - a. ABB: www.electrification.us.abb.com/#sle.
 - b. Eaton Corporation: www.eaton.com/#sle.
 - c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - d. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
 - e. nVent; Caddy: www.nvent.com/#sle.
 - f. Substitutions: See Section 016000 - Product Requirements.
 2. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
 3. Conduit Clamps: Bolted type unless otherwise indicated.
 4. Products:
 - a. Gripple, Inc; Universal Bracket: www.gripple.com/#sle.
 - b. Gripple, Inc; Fast Trak: www.gripple.com/#sle.
 - c. Gripple, Inc; Universal Clamp (Threaded): www.gripple.com/#sle.
 - d. Gripple, Inc; Low Profile Bracket Kits: www.gripple.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
- C. Outlet Box Supports: Hangers and brackets suitable for boxes to be supported.
1. Manufacturers:
 - a. ABB: www.electrification.us.abb.com/#sle.
 - b. Eaton Corporation: www.eaton.com/#sle.
 - c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - d. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
 - e. nVent; Caddy: www.nvent.com/#sle.
 - f. Substitutions: See Section 016000 - Product Requirements.
- D. Metal Channel/Strut Framing Systems:
1. Manufacturers:
 - a. ABB: www.electrification.us.abb.com/#sle.
 - b. Atkore International Inc; Unistrut: www.unistrut.us/#sle.
 - c. Eaton Corporation: www.eaton.com/#sle.

- d. Substitutions: See Section 016000 - Product Requirements.
 - e. Source Limitations: Furnish channel/strut and associated fittings, accessories, and hardware produced by single manufacturer.
 - 2. Description: Factory-fabricated, continuous-slot, metal channel/strut and associated fittings, accessories, and hardware required for field assembly of supports.
 - 3. Comply with MFMA-4.
 - 4. Channel/Strut Used as Raceway, Where Indicated: Listed and labeled as complying with UL 5B.
 - 5. Channel Material:
 - a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
 - 6. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch.
 - 7. Minimum Channel Dimensions: 1-5/8 inch wide by 13/16 inch high.
- E. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.
- 1. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Equipment Supports: 1/2-inch diameter.
 - b. Busway Supports: 1/2-inch diameter.
 - c. Single Conduit up to 1-inch (27 mm) Trade Size: 1/4-inch diameter.
 - d. Single Conduit Larger than 1-inch (27 mm) Trade Size: 3/8-inch diameter.
 - e. Trapeze Support for Multiple Conduits: 3/8-inch diameter.
 - f. Outlet Boxes: 1/4-inch diameter.
 - g. Luminaires: 1/4-inch diameter.
- F. Nonpenetrating Rooftop Supports for Low-Slope Roofs:
- 1. Manufacturers:
 - a. Atkore International Inc; Unistrut: www.unistrut.us/#sle.
 - b. Eaton Corporation: www.eaton.com/#sle.
 - c. nVent; Caddy: www.nvent.com/#sle.
 - d. PHP Systems/Design: www.phpsd.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
 - 2. Description: Steel pedestals with thermoplastic or rubber bases that rest on top of roofing membrane, not requiring attachment to roof structure and not penetrating roofing assembly, with support fixtures as specified.
 - 3. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 - 4. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
 - 5. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.
- G. Anchors and Fasteners:
- 1. Manufacturers - Mechanical Anchors:
 - a. Dewalt: anchors.dewalt.com/#sle.
 - b. Hilti, Inc: www.hilti.com/#sle.
 - c. ITW Red Head, a division of Illinois Tool Works, Inc: www.itwredhead.com/#sle.

- d. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
- e. Substitutions: See Section 016000 - Product Requirements.
- 2. Manufacturers - Powder-Actuated Fastening Systems:
 - a. Dewalt: anchors.dewalt.com/#sle.
 - b. Hilti, Inc: www.hilti.com/#sle.
 - c. ITW Ramset, a division of Illinois Tool Works, Inc: www.ramset.com/#sle.
 - d. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
- 3. Unless otherwise indicated and where not otherwise restricted, use anchor and fastener types indicated for specified applications.
- 4. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
- 5. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
- 6. Hollow Masonry: Use toggle bolts.
- 7. Hollow Stud Walls: Use toggle bolts.
- 8. Steel: Use beam clamps, machine bolts, or welded threaded studs.
- 9. Sheet Metal: Use sheet metal screws.
- 10. Wood: Use wood screws.
- 11. Plastic and lead anchors are not permitted.
- 12. Powder-actuated fasteners are not permitted.
- 13. Hammer-driven anchors and fasteners are not permitted.
- 14. Preset Concrete Inserts: Continuous metal channel/strut and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Manufacturer: Same as manufacturer of metal channel/strut framing system.
 - b. Comply with MFMA-4.
 - c. Channel Material: Use galvanized steel.
 - d. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch minimum base metal thickness.
- 15. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install hangers and supports in accordance with NECA 1.

- C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- E. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- F. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- H. Equipment Support and Attachment:
 - 1. Use metal, fabricated supports or supports assembled from metal channel/strut to support equipment as required.
 - 2. Use metal channel/strut secured to studs to support equipment surface mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel/strut to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 - 4. Unless otherwise indicated, mount floor-mounted equipment on properly sized concrete pad 4 inches in height; see Section 033000.
 - 5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- I. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
- J. Secure fasteners in accordance with manufacturer's recommended torque settings.
- K. Remove temporary supports.
- L. Identify independent electrical component support wires above accessible ceilings, where permitted, with color distinguishable from ceiling support wires in accordance with NFPA 70.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Inspect support and attachment components for damage and defects.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

- D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION 260529

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SECTION 260533.13 - CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Galvanized steel rigid metal conduit (RMC).
- B. Stainless steel rigid metal conduit (RMC).
- C. Galvanized steel intermediate metal conduit (IMC).
- D. Stainless steel intermediate metal conduit (IMC).
- E. PVC-coated galvanized steel rigid metal conduit (RMC).
- F. Flexible metal conduit (FMC).
- G. Liquidtight flexible metal conduit (LFMC).
- H. Galvanized steel electrical metallic tubing (EMT).
- I. Rigid polyvinyl chloride (PVC) conduit.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete encasement of conduits.
- B. Section 078400 - Firestopping.
- C. Section 260526 - Grounding and Bonding for Electrical Systems.
 - 1. Includes additional requirements for fittings for grounding and bonding.
- D. Section 260529 - Hangers and Supports for Electrical Systems.
- E. Section 260548 - Vibration and Seismic Controls for Electrical Systems.
- F. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- G. Section 312316.13 - Trenching: Excavating, bedding, and backfilling.

1.3 REFERENCE STANDARDS

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2020.
- B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S); 2020.
- C. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit; 2018.
- D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- E. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2020.
- F. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); 2017.
- G. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.
- H. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Metal Conduit and Intermediate Metal Conduit; 2018.
- I. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2020.
- J. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2021.
- K. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- L. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.
- M. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
- N. UL 6A - Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel; Current Edition, Including All Revisions.
- O. UL 360 - Liquid-Tight Flexible Metal Conduit; Current Edition, Including All Revisions.
- P. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.
- Q. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
- R. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.

- S. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.
- T. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.
- U. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.
- V. UL 2419 - Outline of Investigation for Electrically Conductive Corrosion Resistant Compounds; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate minimum sizes of conduits with actual type and quantity of conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate arrangement of conduits with structural members, ductwork, piping, equipment, and other potential conflicts.
 - 3. Verify exact conduit termination locations required for boxes, enclosures, and equipment.
 - 4. Coordinate work to provide roof penetrations that preserve integrity of roofing system and do not void roof warranty.
 - 5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not begin installation of conductors and cables until installation of conduit between termination points is complete.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.
- C. Project Record Documents: Record actual routing for conduits installed underground and conduits 2-inch (53 mm) trade size and larger.

1.6 QUALITY ASSURANCE

PART 2 PRODUCTS

2.1 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, manufacturer's instructions, and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use conduit types indicated for specified applications. Where more than one listed application applies, comply with most restrictive requirements. Where conduit type for particular application is not specified, use galvanized steel rigid metal conduit.
- C. Underground:
 - 1. Under Slab on Grade: Use rigid PVC conduit.
 - 2. Exterior, Direct-Buried: Use rigid PVC conduit.
 - 3. Exterior, Embedded Within Concrete: Use rigid PVC conduit.
 - 4. Where rigid polyvinyl chloride (PVC) conduit is provided, transition to galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), or stainless steel intermediate metal conduit (IMC) where emerging from underground.
 - 5. Where rigid polyvinyl (PVC) conduit larger than 2-inch (53 mm) trade size is provided, use PVC-coated galvanized steel rigid metal conduit (RMC) elbows for bends.
 - 6. Where galvanized steel rigid metal conduit (RMC) or galvanized steel intermediate metal conduit (IMC) is installed in direct contact with earth, use corrosion protection tape, factory-applied corrosion protection coating, or field-applied corrosion protection compound acceptable to authorities having jurisdiction to provide supplementary corrosion protection.
- D. Embedded Within Concrete:
 - 1. Within Slab on Grade: Not permitted.
 - 2. Within Slab Above Ground: Not permitted.
 - 3. Within Concrete Walls Above Ground: Use rigid PVC conduit.
 - 4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit (RMC) where emerging from concrete.
- E. Concealed Within Masonry Walls: Use galvanized steel electrical metallic tubing (EMT).
- F. Concealed Within Hollow Stud Walls: Use galvanized steel electrical metallic tubing (EMT).
- G. Concealed Above Accessible Ceilings: Use galvanized steel electrical metallic tubing (EMT).

- H. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit (RMC) or stainless steel rigid metal conduit (RMC).
- I. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel electrical metallic tubing (EMT).
- J. Exposed, Interior, Subject to Physical Damage: Use galvanized steel electrical metallic tubing (EMT).
 - 1. Locations subject to physical damage include, but are not limited to:
 - a. Where exposed below 8 feet, except within electrical and communication rooms or closets.
 - b. Where exposed below 20 feet in warehouse areas.
- K. Exposed, Interior, Subject to Severe Physical Damage: Use galvanized steel rigid metal conduit (RMC).
 - 1. Locations subject to severe physical damage include, but are not limited to:
 - a. High traffic industrial and warehouse areas where exposed below 8 feet, except within electrical and communication rooms or closets.
 - b. Where exposed below 20 feet in industrial manufacturing areas.
- L. Exposed, Exterior, Not Subject to Severe Physical Damage: Use galvanized steel rigid metal conduit (RMC).
- M. Exposed, Exterior, Subject to Severe Physical Damage: Use galvanized steel rigid metal conduit (RMC) or stainless steel rigid metal conduit (RMC).
 - 1. Exterior locations subject to severe physical damage include, but are not limited to:
 - a. Where exposed to vehicular traffic below 20 feet.
- N. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit (RMC) or stainless steel rigid metal conduit (RMC).
- O. Corrosive Locations Above Ground: Use stainless steel rigid metal conduit (RMC) or PVC-coated galvanized steel rigid metal conduit (RMC).
 - 1. Corrosive locations include, but are not limited to:
 - a. Cooling towers.
 - b. Electroplating operations.
 - c. Swimming pools and associated equipment areas.
 - d. Wastewater treatment facilities.
 - e. Marine environments.
 - f. Chemical storage areas.
- P. Hazardous/Classified Locations: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), or PVC-coated galvanized steel rigid metal conduit (RMC).

- Q. Flexible Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit (FMC).
 - 1. Maximum Length: 6 feet.
- R. Flexible Connections to Vibrating Equipment:
 - 1. Dry Locations: Use flexible metal conduit (FMC).
 - 2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit (LFMC).
 - 3. Maximum Length: 6 feet unless otherwise indicated.
 - 4. Vibrating equipment includes, but is not limited to:
 - a. Transformers.
 - b. Motors.
- S. Fished in Existing Walls, Where Necessary: Use flexible metal conduit (FMC).

2.2 CONDUIT - GENERAL REQUIREMENTS

- A. Comply with NFPA 70.
- B. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling mandrel through them.
- C. Fittings for Grounding and Bonding: See Section 260526 for additional requirements.
- D. Provide conduit, fittings, supports, and accessories required for complete raceway system.
- E. Provide products listed, classified, and labeled as suitable for purpose intended.
- F. Minimum Conduit Size, Unless Otherwise Indicated:
 - 1. Branch Circuits: 3/4-inch trade size.
 - 2. Branch Circuit Homeruns: 3/4-inch trade size.
 - 3. Control Circuits: 1/2-inch trade size.
 - 4. Flexible Connections to Luminaires: 3/8-inch trade size.
 - 5. Underground, Interior: 3/4-inch trade size.
 - 6. Underground, Exterior: 1-inch trade size.
- G. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.3 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
 - 1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
 - 2. Nucor Tubular Products: www.nucortubular.com/#sle.

3. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
4. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
5. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

C. Fittings:

1. Manufacturers:
 - a. ABB; T&B: www.electrification.us.abb.com/#sle.
 - b. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
 - c. Bridgeport Fittings Inc: www.bptfittings.com/#sle.
 - d. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6.
3. Hazardous/Classified Locations: Use fittings listed and labeled as complying with UL 1203 for classification of installed location.
4. Material: Use steel or malleable iron.
 - a. Where not subject to severe corrosive influence, stainless steel or aluminum fittings may be used.
 - b. Do not use die cast zinc fittings.
5. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.4 STAINLESS STEEL RIGID METAL CONDUIT (RMC)

A. Manufacturers:

1. Calbrite, a division of Atkore International: www.calbrite.com/#sle.
2. Gibson Stainless & Specialty Inc: www.gibsonstainless.com/#sle.
3. Patriot Industries, a division of Patriot Aluminum Products LLC: www.patriotsas.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type RMC stainless steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6A.

1. Material: Type 304 or 316 stainless steel.

C. Fittings:

1. Manufacturers:
 - a. Calbrite, a division of Atkore International: www.calbrite.com/#sle.
 - b. Eaton: www.eaton.com/#sle.
 - c. Gibson Stainless & Specialty Inc: www.gibsonstainless.com/#sle.
 - d. Patriot Industries, a division of Patriot Aluminum Products LLC: www.patriotsas.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.

2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6A.
3. Hazardous/Classified Locations: Use fittings listed and labeled as complying with UL 1203 for classification of installed location.
4. Material: Use stainless steel with corrosion resistance equivalent to conduit.
5. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.5 GALVANIZED STEEL INTERMEDIATE METAL CONDUIT (IMC)

A. Manufacturers:

1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
2. Nucor Tubular Products: www.nucortubular.com/#sle.
3. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
4. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
5. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

C. Fittings:

1. Manufacturers:

- a. ABB; T&B: www.electrification.us.abb.com/#sle.
- b. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
- c. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
- d. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
- e. Substitutions: See Section 016000 - Product Requirements.

2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 1242.
3. Hazardous/Classified Locations: Use fittings listed and labeled as complying with UL 1203 for classification of installed location.
4. Material: Use steel or malleable iron.
 - a. Where not subject to severe corrosive influence, stainless steel or aluminum fittings may be used.
 - b. Do not use die cast zinc fittings.
5. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.6 STAINLESS STEEL INTERMEDIATE METAL CONDUIT (IMC)

A. Manufacturers:

1. Calbrite, a division of Atkore International: www.calbrite.com/#sle.
2. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

1. Material: Type 304 or 316 stainless steel.

C. Fittings:

1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 1242.
2. Hazardous/Classified Locations: Use fittings listed and labeled as complying with UL 1203 for classification of installed location.
3. Material: Use stainless steel with corrosion resistance equivalent to conduit.
4. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.7 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Manufacturers:

1. ABB; Ocal: www.electrification.us.abb.com/#sle.
2. Calbond, a division of Atkore International www.calbond.com/#sle
3. Robroy Industries: www.robroy.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.

- C. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil, 0.040 inch.

- D. Interior Coating: Urethane, minimum thickness of 2 mil, 0.002 inch.

E. PVC-Coated Boxes and Fittings:

1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
2. Nonhazardous Locations: Use boxes and fittings listed and labeled as complying with UL 514A, UL 514B, or UL 6.
3. Hazardous/Classified Locations: Use fittings listed and labeled as complying with UL 1203 for classification of installed location.
4. Material: Use steel or malleable iron.
5. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil, 0.040 inch.
6. Interior Coating: Urethane, minimum thickness of 2 mil, 0.002 inch.

- F. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil, 0.015 inch.

2.8 FLEXIBLE METAL CONDUIT (FMC)

A. Manufacturers:

1. AFC Cable Systems, a division of Atkore International: www.afcweb.com/#sle.
2. Electri-Flex Company: www.electriflex.com/#sle.

3. International Metal Hose: www.metalhose.com/#sle.
 4. Substitutions: See Section 016000 - Product Requirements.
- B. Description: NFPA 70, Type FMC standard-wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems.
- C. Fittings:
1. Manufacturers:
 - a. ABB; T&B: www.electrification.us.abb.com/#sle.
 - b. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
 - c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 3. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.

2.9 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Manufacturers:
1. AFC Cable Systems, a division of Atkore International: www.afcweb.com/#sle.
 2. Electri-Flex Company: www.electriflex.com/#sle.
 3. International Metal Hose: www.metalhose.com/#sle.
 4. Substitutions: See Section 016000 - Product Requirements.
- B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- C. Fittings:
1. Manufacturers:
 - a. ABB; T&B: www.electrification.us.abb.com/#sle.
 - b. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
 - c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 3. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.

2.10 GALVANIZED STEEL ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
 2. Nucor Tubular Products: www.nucortubular/#sle.
 3. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.

4. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
 5. Substitutions: See Section 016000 - Product Requirements.
- B. Description: NFPA 70, Type EMT galvanized steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- C. Fittings:
1. Manufacturers:
 - a. ABB; T&B: www.electrification.us.abb.com/#sle.
 - b. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
 - c. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
 - d. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 3. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.
 4. Connectors and Couplings: Use compression/gland type.
 - a. Do not use indenter type connectors and couplings.
 5. Damp or Wet Locations, Where Permitted: Use fittings listed for use in wet locations.
 6. Embedded Within Concrete, Where Permitted: Use fittings listed as concrete-tight. Fittings that require taping to be concrete-tight are acceptable.

2.11 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

- A. Manufacturers:
1. ABB; Carlon: www.carlon.com/#sle.
 2. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
 3. Cantex Inc: www.cantexinc.com/#sle.
 4. Heritage Plastics, a division of Atkore International: www.heritageplastics.com/#sle.
 5. JM Eagle: www.jmeagle.com/#sle.
 6. Substitutions: See Section 016000 - Product Requirements.
- B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.
- C. Fittings:
1. Manufacturer: Same as manufacturer of conduit to be connected.
 2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.12 ACCESSORIES

- A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil, 0.020 inch.

- B. Conduit Joint Compound: Corrosion-resistant, electrically conductive compound listed as complying with UL 2419; suitable for use with conduit to be installed.
- C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- D. Pull Strings: Use nylon or polyester tape with average breaking strength of not less than 1,250 lbf.
- E. Foam Conduit Sealant:
 - 1. Removable, two-part, closed-cell foam, specifically designed for sealing conduit openings against water, moisture, gases, and dust.
 - 2. Suitable for use with conductors/cables and associated insulation/jackets to be installed.
 - 3. Rated to hold minimum of 10 ft water head pressure.
 - 4. Products:
 - a. American Polywater Corporation; Polywater AFT Foam Duct Sealant: www.polywater.com/#sle.
 - b. American Polywater Corporation; Polywater FST Foam Duct Sealant: www.polywater.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.
- F. Conduit Mechanical Seals:
 - 1. Listed as complying with UL 514B.
 - 2. Specifically designed for sealing conduit openings against water, moisture, gases, and dust.
 - 3. Suitable for sealing around conductors/cables to be installed.
 - 4. Products:
 - a. American Polywater Corporation; PHRD SG Mechanical Seals: www.polywater-haufftechnik.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- G. Sealing Compound for Hazardous/Classified Location Sealing Fittings: Listed for use with particular fittings to be installed.
- H. Sealing Systems for Concrete Penetrations:
 - 1. Sleeves: Provide water stop ring or cement coating that bonds to concrete to prevent water infiltration.
 - 2. Rate for minimum of 40 psig; suitable for sealing around conduits to be installed.
 - 3. Products:
 - a. American Polywater Corporation; PZVR Cement-Coated Concrete Wall Sleeves: www.polywater-haufftechnik.com/#sle.
 - b. American Polywater Corporation; PHSD Mechanical Seals: www.polywater-haufftechnik.com/#sle.
 - c. American Polywater Corporation; PHSI 150 Varia Double Wall Inserts: www.polywater-haufftechnik.com/#sle.

- d. American Polywater Corporation; PGKD Modular Seals: www.polywater-haufftechnik.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
- I. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for conduits and roofing system to be installed; designed to accommodate existing penetrations where applicable.
- 1. Products:
 - a. Menzies Metal Products; Electrical Roof Stack and Cap: www.menzies-metal.com/#sle.
 - b. Menzies Metal Products; Electrical Retro Box: www.menzies-metal.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.
- J. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for conduits and facade materials to be installed.
- 1. Products:
 - a. Quickflash Weatherproofing Products, Inc: www.quickflashproducts.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- K. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.
- 1. Products:
 - a. HoldRite, a brand of Reliance Worldwide Corporation; HydroFlame Pro Series/HydroFlame Custom Built: www.holdrite.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- L. Duct Bank Spacers: Nonmetallic; designed for maintaining conduit/duct spacing for concrete encasement in open trench installation; suitable for conduit/duct arrangement to be installed.
- 1. Products:
 - a. Advance Products & Systems, LLC; Duct Bank Spacers: www.apsonline.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- M. Bore Spacers: Nonmetallic; designed for maintaining conduit/duct spacing for installation within casing; furnished with roller wheels to facilitate installation, openings to facilitate grout flow, and holes for stabilization cable; suitable for casing and conduit/duct arrangement to be installed.
- 1. Products:
 - a. Advance Products & Systems, LLC; Bore Spacers: www.apsonline.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive conduits.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install conduit in accordance with NECA 1.
- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- D. Install intermediate metal conduit (IMC) in accordance with NECA 101.
- E. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by manufacturer.
- F. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
- G. Conduit Routing:
 - 1. Unless dimensioned, conduit routing indicated is diagrammatic.
 - 2. When conduit destination is indicated without specific routing, determine exact routing required.
 - 3. Conceal conduits unless specifically indicated to be exposed.
 - 4. Conduits in the following areas may be exposed, unless otherwise indicated:
 - a. Electrical rooms.
 - b. Mechanical equipment rooms.
 - c. Within joists in areas with no ceiling.
 - 5. Unless otherwise approved, do not route exposed conduits:
 - a. Across floors.
 - b. Across roofs.
 - c. Across top of parapet walls.
 - d. Across building exterior surfaces.
 - 6. Conduits installed underground or embedded in concrete may be routed in shortest possible manner unless otherwise indicated. Route other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
 - 7. Arrange conduit to maintain adequate headroom, clearances, and access.

8. Arrange conduit to provide no more than equivalent of four 90-degree bends between pull points.
9. Arrange conduit to provide no more than 150 feet between pull points.
10. Route conduits above water and drain piping where possible.
11. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
12. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
13. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
 - a. Heaters.
 - b. Hot water piping.
 - c. Flues.
14. Group parallel conduits in same area on common rack.

H. Conduit Support:

1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction; see Section 260529.
2. Provide required vibration isolation and/or seismic controls; see Section 260548.
3. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
4. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
5. Use conduit strap to support single surface-mounted conduit.
 - a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
6. Use metal channel/strut with accessory conduit clamps to support multiple parallel surface-mounted conduits.
7. Use conduit clamp to support single conduit from beam clamp or threaded rod.
8. Use trapeze hangers assembled from threaded rods and metal channel/strut with accessory conduit clamps to support multiple parallel suspended conduits.
9. Use nonpenetrating rooftop supports to support conduits routed across rooftops, where approved.
10. Use of spring steel conduit clips for support of conduits is not permitted.
11. Use of wire for support of conduits is not permitted.
12. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with most stringent requirements.

I. Connections and Terminations:

1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.

4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
 5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
 6. Provide insulating bushings, insulated throats, or listed metal fittings with smooth, rounded edges at conduit terminations to protect conductors.
 7. Secure joints and connections to provide mechanical strength and electrical continuity.
- J. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
 2. Make penetrations perpendicular to surfaces unless otherwise indicated.
 3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
 4. Conceal bends for conduit risers emerging above ground.
 5. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
 6. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
 7. Install firestopping to preserve fire resistance rating of partitions and other elements; see Section 078400.
- K. Underground Installation:
1. Provide trenching and backfilling; see Section 312316.13.
 2. Minimum Cover, Unless Otherwise Indicated or Required:
 - a. Underground, Exterior: 24 inches.
 - b. Under Slab on Grade: 12 inches to bottom of slab.
 3. Provide underground warning tape along entire conduit length; see Section 260553.
- L. Embedment Within Structural Concrete Slabs (only where approved by Structural Engineer):
1. Secure conduits to prevent floating or movement during pouring of concrete.
- M. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide minimum concrete cover of 3 inches on all sides unless otherwise indicated; see Section 033000.
- N. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.

2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
3. Where conduits are subject to earth movement by settlement or frost.

O. Conduit Sealing:

1. Use foam conduit sealant to prevent entry of moisture and gases. This includes, but is not limited to:
 - a. Where conduits enter building from outside.
 - b. Where service conduits enter building from underground distribution system.
 - c. Where conduits enter building from underground.
 - d. Where conduits may transport moisture to contact live parts.
2. Where conduits cross barriers between areas of potential substantial temperature differential, use foam conduit sealant at accessible point near penetration to prevent condensation. This includes, but is not limited to:
 - a. Where conduits pass from outdoors into conditioned interior spaces.
 - b. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
 - c. Where conduits penetrate coolers or freezers.
3. Where conduits cross boundaries of hazardous/classified locations, provide identified/listed sealing fittings or conduit mechanical seals as approved by authorities having jurisdiction; locate as indicated or in accordance with NFPA 70.

P. Provide pull string in each empty conduit and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.

Q. Provide grounding and bonding; see Section 260526.

R. Identify conduits; see Section 260553.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- C. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.
- D. Correct deficiencies and replace damaged or defective conduits.

3.4 CLEANING

- A. Clean interior of conduits to remove moisture and foreign matter.

3.5 PROTECTION

- A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION 260533.13

SECTION 260533.16 - BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
- C. Boxes and enclosures for integrated power, data, and audio/video.
- D. Boxes for hazardous (classified) locations.
- E. Floor boxes.
- F. Underground boxes/enclosures.
- G. Accessories.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete.
- B. Section 083100 - Access Doors and Panels: Panels for maintaining access to concealed boxes.
- C. Section 260529 - Hangers and Supports for Electrical Systems.
- D. Section 260533.13 - Conduit for Electrical Systems:
 - 1. Conduit bodies and other fittings.
 - 2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.
- E. Section 260548 - Vibration and Seismic Controls for Electrical Systems.
- F. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- G. Section 262726 - Wiring Devices:
 - 1. Wall plates.
 - 2. Floor box service fittings.
 - 3. Poke-through assemblies.
 - 4. Additional requirements for locating boxes for wiring devices.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2016.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2020.
- D. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.
- E. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013 (Reaffirmed 2020).
- F. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports; 2013 (Reaffirmed 2020).
- G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. SCTE 77 - Specifications for Underground Enclosure Integrity; 2017.
- I. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- J. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- K. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.
- L. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.
- M. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers; Current Edition, Including All Revisions.
- N. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, cabinets and enclosures, floor boxes, and underground boxes/enclosures.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. See Section 016000 - Product Requirements, for additional provisions.
 2. Keys for Lockable Enclosures: Two of each different key.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 BOXES

- A. General Requirements:
 - 1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
 - 2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
 - 3. Provide products listed, classified, and labeled as suitable for the purpose intended.
 - 4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
 - 5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
- B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
 - 1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
 - 2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
 - 3. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.
 - 4. Use nonmetallic boxes where exposed rigid PVC conduit is used.
 - 5. Use suitable concrete type boxes where flush-mounted in concrete.
 - 6. Use suitable masonry type boxes where flush-mounted in masonry walls.
 - 7. Use raised covers suitable for the type of wall construction and device configuration where required.
 - 8. Use shallow boxes where required by the type of wall construction.
 - 9. Do not use "through-wall" boxes designed for access from both sides of wall.
 - 10. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
 - 11. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
 - 12. Nonmetallic Boxes: Comply with NEMA OS 2, and list and label as complying with UL 514C.
 - 13. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
 - 14. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
 - 15. Minimum Box Size, Unless Otherwise Indicated:

- a. Wiring Devices: 4 inch square by 2-1/8 inch deep (100 by 54 mm) trade size.
 - b. Communications Systems Outlets: 4 inch square by 2-1/8 inch (100 by 54 mm) trade size.
 - c. Ceiling Outlets: 4 inch octagonal or square by 2-1/8 inch deep (100 by 54 mm) trade size.
16. Wall Plates: Comply with Section 262726.
17. Manufacturers:
- a. Cooper Crouse-Hinds, a division of Eaton Corporation; _____: www.cooperindustries.com/#sle.
 - b. Hubbell Incorporated; Bell Products; _____: www.hubbell-rtb.com/#sle.
 - c. Hubbell Incorporated; RACO Products; _____: www.hubbell-rtb.com/#sle.
 - d. O-Z/Gedney, a brand of Emerson Electric Co; _____: www.emerson.com/#sle.
 - e. Thomas & Betts Corporation; _____: www.tnb.com/#sle.
 - f. Substitutions: See Section 016000 - Product Requirements.
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
 2. NEMA 250 Environment Type, Unless Otherwise Indicated:
 - a. Indoor Clean, Dry Locations: Type 1, painted steel.
 - b. Outdoor Locations: Type 3R, painted steel.
 3. Junction and Pull Boxes Larger Than 100 cubic inches:
 - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
 - b. Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.
 4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
 - a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.
 - b. Back Panels: Painted steel, removable.
 - c. Terminal Blocks: Provide voltage/current ratings and terminal quantity suitable for purpose indicated, with 25 percent spare terminal capacity.
 5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.
 6. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation; _____: www.cooperindustries.com/#sle.
 - b. Hoffman, a brand of Pentair Technical Products; _____: www.hoffmanonline.com/#sle.
 - c. Hubbell Incorporated; Wiegmann Products; _____: www.hubbell-wiegmann.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- D. Boxes and Enclosures for Integrated Power, Data, and Audio/Video: Size and configuration as indicated or as required with partitions to separate services; field-connected gangable boxes may be used.
1. Manufacturers:
 - a. Hubbell Incorporated; _____: www.hubbell.com/#sle.

- b. Substitutions: See Section 016000 - Product Requirements.
- E. Boxes for Hazardous (Classified) Locations: Listed and labeled as complying with UL 1203 for the classification of the installed location.
- 1. Manufacturers:
 - a. Appleton, a brand of Emerson Electric Co; _____: www.emerson.com/#sle.
 - b. Cooper Crouse-Hinds, a division of Eaton Corporation; _____: www.cooperindustries.com/#sle.
 - c. Hubbell Incorporated; Killark Products; _____: www.hubbell-killark.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- F. Floor Boxes:
- 1. Description: Floor boxes compatible with floor box service fittings provided in accordance with Section 262726; with partitions to separate multiple services; furnished with all components, adapters, and trims required for complete installation.
 - 2. Use cast iron floor boxes within slab on grade.
 - 3. Use sheet-steel or cast iron floor boxes within slab above grade.
 - 4. Metallic Floor Boxes: Fully adjustable (with integral means for leveling adjustment prior to and after concrete pour).
 - 5. Manufacturer: Same as manufacturer of floor box service fittings.
- G. Underground Boxes/Enclosures:
- 1. Description: In-ground, open bottom boxes furnished with flush, non-skid covers with legend indicating type of service and stainless steel tamper resistant cover bolts.
 - 2. Size: As indicated on drawings.
 - 3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 12 inches.
 - 4. Provide logo on cover to indicate type of service.
 - 5. Applications:
 - a. Sidewalks and Landscaped Areas Subject Only to Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77, Tier 8 load rating.
 - b. Parking Lots, in Areas Subject Only To Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77, Tier 22 load rating.
 - c. Do not use polymer concrete enclosures in areas subject to deliberate vehicular traffic.
 - 6. Polymer Concrete Underground Boxes/Enclosures: Comply with SCTE 77.
 - a. Manufacturers:
 - 1) Hubbell Incorporated; Quazite Products; _____: www.hubbellpowersystems.com/#sle.
 - 2) MacLean Highline; _____: www.macleanhigline.com/#sle.
 - 3) Oldcastle Precast, Inc; _____: www.oldcastleprecast.com/#sle.
 - 4) Substitutions: See Section 016000 - Product Requirements.
 - b. Combination fiberglass/polymer concrete boxes/enclosures are acceptable.
 - c. Product(s):

- 1) MacLean Highline PHA Series: Straight wall, all-polymer concrete splice box/pull box; available Tier 8, Tier 15, and Tier 22 load ratings.
- 2) MacLean Highline CHA Series: Fiberglass/polymer concrete splice box/pull box; available Tier 8 and Tier 15 load ratings.
- 3) MacLean Highline CVA Series: Fiberglass/polymer concrete splice vault; available Tier 8, Tier 15, and Tier 22 load ratings.

2.2 ACCESSORIES

- A. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for boxes and facade materials to be installed.
 1. Manufacturers:
 - a. Quickflash Weatherproofing Products, Inc: www.quickflashproducts.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive boxes.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide separate boxes for emergency power and normal power systems.
- E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.
- G. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.

H. Box Locations:

1. Locate boxes to be accessible. Provide access panels in accordance with Section 083100 as required where approved by the Architect.
2. Unless dimensioned, box locations indicated are approximate.
3. Locate boxes so that wall plates do not span different building finishes.
4. Locate boxes so that wall plates do not cross masonry joints.
5. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
6. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
7. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.
8. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
 - a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
 - b. Do not install flush-mounted boxes with area larger than 16 square inches or such that the total aggregate area of openings exceeds 100 square inches for any 100 square feet of wall area.
9. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 260533.13.
10. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:
 - a. Concealed above accessible suspended ceilings.
 - b. Within joists in areas with no ceiling.
 - c. Electrical rooms.
 - d. Mechanical equipment rooms.

I. Box Supports:

1. Secure and support boxes in accordance with NFPA 70 and Section 260529 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide required seismic controls in accordance with Section 260548.
3. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
4. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.

J. Install boxes plumb and level.

K. Flush-Mounted Boxes:

1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.

3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
- L. Floor-Mounted Cabinets: Mount on properly sized 4 inch high concrete pad constructed in accordance with Section 033000.
- M. Install boxes as required to preserve insulation integrity.
- N. Metallic Floor Boxes: Install box level at the proper elevation to be flush with finished floor.
- O. Underground Boxes/Enclosures:
 1. Install enclosure on gravel base, minimum 6 inches deep.
 2. Flush-mount enclosures located in concrete or paved areas.
 3. Mount enclosures located in landscaped areas with top at 1 inch above finished grade.
 4. Provide cast-in-place concrete collar constructed in accordance with Section 033000, minimum 10 inches wide by 12 inches deep, around enclosures that are not located in concrete areas.
 5. Install additional bracing inside enclosures in accordance with manufacturer's instructions to minimize box sidewall deflections during backfilling. Backfill with cover bolted in place.
- P. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- Q. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.
- R. Close unused box openings.
- S. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- T. Provide grounding and bonding in accordance with Section 260526.
- U. Identify boxes in accordance with Section 260553.

3.3 CLEANING

- A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.4 PROTECTION

- A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION 260533.16

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Wire and cable markers.
- D. Voltage markers.
- E. Underground warning tape.
- F. Floor marking tape.
- G. Warning signs and labels.

1.2 RELATED REQUIREMENTS

- A. Section 099113 - Exterior Painting.
- B. Section 099123 - Interior Painting.
- C. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.
- D. Section 260536 - Cable Trays for Electrical Systems: Additional identification requirements for cable tray systems.
- E. Section 260573 - Power System Studies: Arc flash hazard warning labels.
- F. Section 262300 - Low-Voltage Switchgear: Factory-installed mimic bus.
- G. Section 262726 - Wiring Devices - Lutron: Device and wallplate finishes; factory pre-marked wallplates.
- H. Section 271000 - Structured Cabling: Identification for communications cabling and devices.

1.3 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B. NFPA 70E - Standard for Electrical Safety in the Workplace; 2021.
- C. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
- B. Sequencing:
 - 1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
 - 2. Do not install identification products until final surface finishes and painting are complete.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation and installation of product.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.7 FIELD CONDITIONS

- A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.1 IDENTIFICATION REQUIREMENTS

- A. Existing Work: Unless specifically excluded, identify existing elements to remain that are not already identified in accordance with specified requirements.
- B. Identification for Equipment:
 - 1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
 - a. Switchboards:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Use identification nameplate to identify main overcurrent protective device.
 - 5) Use identification nameplate to identify load(s) served for each branch device.
 - b. Panelboards:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
 - 5) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces.
 - 6) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
 - c. Transformers:
 - 1) Identify kVA rating.
 - 2) Identify voltage and phase for primary and secondary.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Identify load(s) served. Include location when not within sight of equipment.
 - d. Enclosed switches, circuit breakers, and motor controllers:
 - 1) Identify voltage and phase.
 - 2) Identify power source and circuit number. Include location when not within sight of equipment.
 - 3) Identify load(s) served. Include location when not within sight of equipment.
 - e. Time Switches:
 - 1) Identify load(s) served and associated circuits controlled. Include location.
 - f. Enclosed Contactors:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.

- 3) Identify configuration, e.g., E.O.E.H. (electrically operated, electrically held) or E.O.M.H. (electrically operated, mechanically held).
- 4) Identify coil voltage.
- 5) Identify load(s) and associated circuits controlled. Include location.
- g. Transfer Switches:
 - 1) Identify voltage and phase.
 - 2) Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.
 - 3) Identify load(s) served. Include location when not within sight of equipment.
 - 4) Identify short circuit current rating based on the specific overcurrent protective device type and settings protecting the transfer switch.
- h. Electricity Meters:
 - 1) Identify load(s) metered.
2. Service Equipment:
 - a. Use identification nameplate to identify each service disconnecting means.
 - b. For buildings or structures supplied by more than one service, or any combination of branch circuits, feeders, and services, use identification nameplate or means of identification acceptable to authority having jurisdiction at each service disconnecting means to identify all other services, feeders, and branch circuits supplying that building or structure. Verify format and descriptions with authority having jurisdiction.
3. Emergency System Equipment:
 - a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.
 - b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.
 - c. Use identification nameplate to identify emergency operating instructions for emergency system equipment.
4. Use voltage marker to identify highest voltage present for each piece of electrical equipment.
5. Use identification nameplate to identify equipment utilizing series ratings, where permitted, in accordance with NFPA 70.
6. Use identification nameplate to identify switchboards and panelboards utilizing a high leg delta system in accordance with NFPA 70.
7. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
8. Use identification label on inside of door at each fused switch to identify required NEMA fuse class and size.
9. Use identification label on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.
10. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
11. Use field-painted floor markings, floor marking tape, or warning labels to identify required equipment working clearances.
 - a. Field-Painted Floor Markings: Alternating black and white stripes, 3 inches wide, painted in accordance with Section 099123 and 099113.

12. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70, including but not limited to the following.
 - a. Service equipment.
 - b. Industrial control panels.
 - c. Motor control centers.
 - d. Elevator control panels.
 - e. Industrial machinery.
 - f. Panelboards.
13. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.
 - a. Minimum Size: 3.5 by 5 inches.
 - b. Legend: Include orange header that reads "WARNING", followed by the word message "Arc Flash and Shock Hazard; Appropriate PPE Required; Do not operate controls or open covers without appropriate personal protection equipment; Failure to comply may result in injury or death; Refer to NFPA 70E for minimum PPE requirements" or approved equivalent.
 - c. Service Equipment: Include the following information in accordance with NFPA 70.
 - 1) Nominal system voltage.
 - 2) Available fault current.
 - 3) Clearing time of service overcurrent protective device(s).
 - 4) Date label applied.
14. Use warning signs to identify electrical hazards for entrances to all rooms and other guarded locations that contain exposed live parts operating at 600 V nominal or less with the word message "DANGER; Electrical hazard; Authorized personnel only" or approved equivalent.
15. Use warning signs to identify electrical hazards for entrances to all buildings, vaults, rooms, or enclosures containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".
16. Use warning labels to identify electrical hazards for equipment, compartments, and enclosures containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".
17. Use warning labels, identification nameplates, or identification labels to identify electrical hazards for equipment where multiple power sources are present with the word message "DANGER; Hazardous voltage; Multiple power sources may be present; Disconnect all electric power including remote disconnects before servicing" or approved equivalent.

C. Identification for Conductors and Cables:

1. Color Coding for Power Conductors 600 V and Less: Comply with Section 260519.
2. Identification for Communications Conductors and Cables: Comply with Section 271000.

3. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
 4. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
 - a. At each source and load connection.
 - b. Within boxes when more than one circuit is present.
 - c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
 - d. In cable tray, at maximum intervals of 20 feet.
 5. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.
 6. Use underground warning tape to identify direct buried cables.
- D. Identification for Raceways:
1. Use voltage markers to identify highest voltage present for accessible conduits at maximum intervals of 20 feet.
 2. Use voltage markers, color-coded bands, or factory-painted conduits to identify systems other than normal power system for accessible conduits.
 - a. Maximum Intervals: 20 feet.
 - b. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches wide.
 - 1) Field-Painting: Comply with Section 099123 and 099113.
 - 2) Vinyl Color Coding Electrical Tape: Comply with Section 260519.
 - c. Color Code:
 - 1) Emergency Power System:
 - (a) Life Safety Branch: Red.
 - (b) Equipment Branch: Green.
 - 2) Fire Alarm System: Red.
 3. Use identification labels or plastic marker tags to identify circuits enclosed for accessible conduits at wall penetrations, at floor penetrations, at roof penetrations, and at equipment terminations when source is not within sight.
 4. Use identification labels or plastic marker tags to identify spare conduits at each end. Identify purpose and termination location.
 5. Use underground warning tape to identify underground raceways.
 6. Use voltage markers to identify highest voltage present for wireways at maximum intervals of 20 feet.
- E. Identification for Cable Tray: Comply with Section 260536.
- F. Identification for Boxes:
1. Use voltage markers to identify highest voltage present.
 2. Use voltage markers or color coded boxes to identify systems other than normal power system.
 - a. Color-Coded Boxes: Field-painted in accordance with Section 099123 and 099113 per the same color code used for raceways.

- b. For exposed boxes in public areas, do not color code.
- 3. Use identification labels to identify circuits enclosed.
 - a. For exposed boxes in public areas, provide identification on inside face of cover.
- 4. Use warning labels to identify electrical hazards for boxes containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".

G. Identification for Devices:

- 1. Identification for Communications Devices: Comply with Section 271000.
- 2. Wiring Device and Wallplate Finishes: Comply with Section 262726.
- 3. Use identification label to identify fire alarm system devices.
 - a. For devices concealed above suspended ceilings, provide additional identification on ceiling tile below device location.
- 4. Use identification label or engraved wallplate to identify serving branch circuit for all receptacles.
 - a. For receptacles in public areas or in areas as directed by Architect, provide identification on inside surface of wallplate.
- 5. Use identification label or engraved wallplate to identify load controlled for wall-mounted control devices controlling loads that are not visible from the control location and for multiple wall-mounted control devices installed at one location.
- 6. Use identification label to identify receptacles protected by upstream GFI protection, where permitted.

H. Identification for Luminaires:

- 1. Use permanent red dot on luminaire frame to identify luminaires connected to emergency power system.

2.2 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:

- 1. Manufacturers:
 - a. Brimar Industries, Inc: www.brimar.com/#sle.
 - b. Kolbi Pipe Marker Co; _____: www.kolbipipemarkers.com/#sle.
 - c. Seton Identification Products; _____: www.seton.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- 2. Materials:
 - a. Indoor Clean, Dry Locations: Use plastic nameplates.
 - b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
- 3. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
 - a. Exception: Provide minimum thickness of 1/8 inch when any dimension is greater than 4 inches.
- 4. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.

5. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
 6. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.
- B. Identification Labels:
1. Manufacturers:
 - a. Brady Corporation; _____: www.bradyid.com/#sle.
 - b. Brother International Corporation: www.brother-usa.com/#sle.
 - c. Panduit Corp: www.panduit.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
 2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
 - a. Use only for indoor locations.
 3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.
- C. Format for Equipment Identification:
1. Minimum Size: 1 inch by 2.5 inches.
 2. Legend:
 - a. System designation where applicable:
 - 1) Emergency Power System: Identify with text "EMERGENCY".
 - 2) Fire Alarm System: Identify with text "FIRE ALARM".
 - b. Equipment designation or other approved description.
 3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height:
 - a. System Designation: 1 inch.
 - b. Equipment Designation: 1/2 inch.
 - c. Other Information: 1/4 inch.
 - d. Exception: Provide minimum text height of 1 inch for equipment located more than 10 feet above floor or working platform.
 5. Color:
 - a. Normal Power System: White text on black background.
 - b. Emergency Power System: White text on red background.
 - c. Fire Alarm System: White text on red background.
- D. Format for General Information and Operating Instructions:
1. Minimum Size: 1 inch by 2.5 inches.
 2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
 3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height: 1/4 inch.
 5. Color: Black text on white background unless otherwise indicated.
 - a. Exceptions:
 - 1) Provide white text on red background for general information or operational instructions for emergency systems.

- 2) Provide white text on red background for general information or operational instructions for fire alarm systems.

E. Format for Caution and Warning Messages:

1. Minimum Size: 2 inches by 4 inches.
2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 1/2 inch.
5. Color: Black text on yellow background unless otherwise indicated.

F. Format for Receptacle Identification:

1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Power source and circuit number or other designation indicated.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Black text on clear background.

G. Format for Control Device Identification:

1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Load controlled or other designation indicated.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Black text on clear background.

H. Format for Fire Alarm Device Identification:

1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Designation indicated and device zone or address.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Red text on white background.

2.3 WIRE AND CABLE MARKERS

A. Manufacturers:

1. Brady Corporation; _____: www.bradyid.com/#sle.
2. HellermannTyton; _____: www.hellermannntyton.com/#sle.
3. Panduit Corp: www.panduit.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.

C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.

- D. Legend: Power source and circuit number or other designation indicated.
- E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
 - 1. Do not use handwritten text.
- F. Minimum Text Height: 1/8 inch.
- G. Color: Black text on white background unless otherwise indicated.

2.4 VOLTAGE MARKERS

- A. Manufacturers:
 - 1. Brady Corporation; _____: www.bradyid.com/#sle.
 - 2. Brimar Industries, Inc: www.brimar.com/#sle.
 - 3. Seton Identification Products; _____: www.seton.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.
- C. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.
- D. Minimum Size:
 - 1. Markers for Equipment: 1 1/8 by 4 1/2 inches.
 - 2. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
 - 3. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.
 - 4. Markers for Junction Boxes: 1/2 by 2 1/4 inches.
- E. Legend:
 - 1. Markers for Voltage Identification: Highest voltage present.
 - 2. Markers for System Identification:
 - a. Emergency Power System: Text "EMERGENCY".
 - b. Other Systems: Type of service.
- F. Color: Black text on orange background unless otherwise indicated.

2.5 UNDERGROUND WARNING TAPE

- A. Manufacturers:
 - 1. Brady Corporation; _____: www.bradyid.com/#sle.
 - 2. Brimar Industries, Inc: www.brimar.com/#sle.
 - 3. Seton Identification Products; _____: www.seton.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.

- B. Materials: Use foil-backed detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.
- C. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.
- D. Legend: Type of service, continuously repeated over full length of tape.
- E. Color:
 - 1. Tape for Buried Power Lines: Black text on red background.
 - 2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.6 FLOOR MARKING TAPE

- A. Manufacturers:
 - 1. Brady Corporation; _____: www.bradyid.com/#sle.
 - 2. Brimar Industries, Inc: www.brimar.com/#sle.
 - 3. Insite Solutions, LLC; _____: www.stop-painting.com/#sle.
 - 4. Seton Identification Products; _____: www.seton.com/#sle.
 - 5. Substitutions: See Section 016000 - Product Requirements.
- B. Floor Marking Tape for Equipment Working Clearance Identification: Self-adhesive vinyl or polyester tape with overlaminate, 3 inches wide, with alternating black and white stripes.

2.7 WARNING SIGNS AND LABELS

- A. Manufacturers:
 - 1. Brimar Industries, Inc: www.brimar.com/#sle.
 - 2. Clarion Safety Systems, LLC; _____: www.clarionsafety.com/#sle.
 - 3. Insite Solutions, LLC; _____: www.stop-painting.com/#sle.
 - 4. Seton Identification Products; _____: www.seton.com/#sle.
 - 5. Substitutions: See Section 016000 - Product Requirements.
- B. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
- C. Warning Signs:
 - 1. Materials:
 - a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
 - b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
 - 2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
 - 3. Minimum Size: 7 by 10 inches unless otherwise indicated.

D. Warning Labels:

1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
 - a. Do not use labels designed to be completed using handwritten text.
2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
3. Minimum Size: 2 by 4 inches unless otherwise indicated.

E. Floor Signs:

1. Materials: Use factory preprinted, self-adhesive vinyl, polyester, or rubber labels with protective overlamine; removable.
2. Minimum Size: 17-inch diameter unless otherwise indicated.

PART 3 EXECUTION

3.1 PREPARATION

- A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
1. Surface-Mounted Equipment: Enclosure front.
 2. Flush-Mounted Equipment: Inside of equipment door.
 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
 4. Elevated Equipment: Legible from the floor or working platform.
 5. Branch Devices: Adjacent to device.
 6. Interior Components: Legible from the point of access.
 7. Conduits: Legible from the floor.
 8. Boxes: Outside face of cover.
 9. Conductors and Cables: Legible from the point of access.
 10. Devices: Outside face of cover.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
1. Do not use adhesives on exterior surfaces except where substrate cannot be penetrated.

- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.
- G. Secure rigid signs using stainless steel screws.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION 260553

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SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Occupancy sensors.
- B. Outdoor motion sensors.
- C. Outdoor photo controls.
- D. Daylighting controls.
- E. Lighting contactors.
- F. Accessories.

1.2 RELATED REQUIREMENTS

- A. Section 253626 - Integrated Automation Lighting Relays.
- B. Section 260529 - Hangers and Supports for Electrical Systems.
- C. Section 260533.16 - Boxes for Electrical Systems.
- D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 262726 - Wiring Devices: Devices for manual control of lighting, including wall switches, wall dimmers, and fan speed controllers.

1.3 REFERENCE STANDARDS

- A. 47 CFR 15 - Radio Frequency Devices; current edition.
- B. ANSI C136.10 - American National Standard for Roadway and Area Lighting Equipment - Locking-Type Photocontrol Devices and Mating Receptacles - Physical and Electrical Interchangeability and Testing; 2017.
- C. ANSI C136.24 - American National Standard for Roadway and Area Lighting Equipment - Nonlocking (Button) Type Photocontrols; 2020.
- D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

- E. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2016.
- F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2020.
- G. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts; 2020.
- H. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2008 (Reaffirmed 2020).
- I. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices; 2017.
- J. NEMA ICS 6 - Industrial Control and Systems: Enclosures; 1993 (Reaffirmed 2016).
- K. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- L. UL 773 - Plug-in, Locking Type Photocontrols for Use with Area Lighting; Current Edition, Including All Revisions.
- M. UL 773A - Nonindustrial Photoelectric Switches for Lighting Control; Current Edition, Including All Revisions.
- N. UL 1472 - Solid-State Dimming Controls; Current Edition, Including All Revisions.
- O. UL 60947-1 - Low-Voltage Switchgear and Controlgear - Part 1: General Rules; Current Edition, Including All Revisions.
- P. UL 60947-4-1 - Low-Voltage Switchgear and Controlgear - Part 4-1: Contactors and Motor-starters - Electromechanical Contactors and Motor-starters; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the placement of lighting control devices with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 2. Coordinate the placement of wall switch occupancy sensors with actual installed door swings.
 - 3. Coordinate the placement of occupancy sensors with millwork, furniture, equipment or other potential obstructions to motion detection coverage installed under other sections or by others.
 - 4. Coordinate the placement of photo sensors for daylighting controls with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.

5. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

B. Sequencing:

1. Do not install lighting control devices until final surface finishes and painting are complete.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.

- B. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.

1. Occupancy Sensors: Include detailed motion detection coverage range diagrams.

C. Shop Drawings:

1. Occupancy Sensors: Provide lighting plan indicating location, model number, and orientation of each occupancy sensor and associated system component.
2. Daylighting Controls: Provide lighting plan indicating location, model number, and orientation of each photo sensor and associated system component.

- D. Field Quality Control Reports.

- E. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

- F. Operation and Maintenance Data: Include detailed information on device programming and setup.

- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 016000 - Product Requirements, for additional provisions.

- H. Project Record Documents: Record actual installed locations and settings for lighting control devices.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.7 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

- B. Provide five year manufacturer warranty for all occupancy sensors.

- C. Provide five year manufacturer warranty for utility grade locking receptacle-mounted outdoor photo controls.
- D. Provide two year manufacturer warranty for all daylighting controls.

PART 2 PRODUCTS

2.1 LIGHTING CONTROL DEVICES - GENERAL REQUIREMENTS

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless specifically indicated to be excluded, provide all required conduit, wiring, connectors, hardware, components, accessories, etc. as required for a complete operating system.
- C. Products for Switching of Electronic Ballasts/Drivers: Tested and rated to be suitable for peak inrush currents specified in NEMA 410.

2.2 OCCUPANCY SENSORS

- A. Manufacturers:
 - 1. Hubbell Incorporated; _____: www.hubbell.com/#sle.
 - 2. Lutron Electronics Company, Inc; _____: www.lutron.com/#sle.
 - 3. Sensor Switch Inc; _____: www.sensorswitch.com/#sle.
 - 4. WattStopper; _____: www.wattstopper.com/#sle.
 - 5. Substitutions: See Section 016000 - Product Requirements.
 - 6. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.
- B. All Occupancy Sensors:
 - 1. Description: Factory-assembled commercial specification grade devices for indoor use capable of sensing both major motion, such as walking, and minor motion, such as small desktop level movements, according to published coverage areas, for automatic control of load indicated.
 - 2. Sensor Technology:
 - a. Passive Infrared (PIR) Occupancy Sensors: Designed to detect occupancy by sensing movement of thermal energy between zones.
 - b. Ultrasonic Occupancy Sensors: Designed to detect occupancy by sensing frequency shifts in emitted and reflected inaudible sound waves.
 - c. Passive Infrared/Ultrasonic Dual Technology Occupancy Sensors: Designed to detect occupancy using a combination of both passive infrared and ultrasonic technologies.
 - d. Passive Infrared/Acoustic Dual Technology Occupancy Sensors: Designed to detect occupancy using a combination of both passive infrared and audible sound sensing technologies.

3. Provide LED to visually indicate motion detection with separate color LEDs for each sensor type in dual technology units.
 4. Operation: Unless otherwise indicated, occupancy sensor to turn load on when occupant presence is detected and to turn load off when no occupant presence is detected during an adjustable turn-off delay time interval.
 5. Dual Technology Occupancy Sensors: Field configurable turn-on and hold-on activation with settings for activation by either or both sensing technologies.
 6. Passive Infrared Lens Field of View: Field customizable by addition of factory masking material, adjustment of integral blinders, or similar means to block motion detection in selected areas.
 7. Turn-Off Delay: Field adjustable, with time delay settings up to 30 minutes.
 8. Compatibility (Non-Dimming Sensors): Suitable for controlling incandescent lighting, low-voltage lighting with electronic and magnetic transformers, fluorescent lighting with electronic and magnetic ballasts, and fractional motor loads, with no minimum load requirements.
 9. Where wired sensors are indicated, wireless sensors are acceptable provided that all components and wiring modifications necessary for proper operation are included.
 10. Wireless Sensors:
 - a. RF Range: 30 feet through typical construction materials.
 - b. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of 47 CFR 15, for Class B application.
 - c. Power: Battery-operated with minimum ten-year battery life.
- C. Wall Switch Occupancy Sensors:
1. All Wall Switch Occupancy Sensors:
 - a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated manual control capability, and no leakage current to load in off mode.
 - b. Unless otherwise indicated or required to control the load indicated on drawings, provide line voltage units with self-contained relay.
 - c. Where indicated, provide two-circuit units for control of two separate lighting loads, with separate manual controls and separately programmable operation for each load.
 - d. Operation: Field selectable to operate either as occupancy sensor (automatic on/off) or as vacancy sensor (manual-on/automatic off).
 - e. Manual-Off Override Control: When used to turn off load while in automatic-on mode, unit to revert back to automatic mode after no occupant presence is detected during the delayed-off time interval.
 - f. Provide selectable audible alert to notify occupant of impending load turn-off.
 - g. Finish: Color to be selected.
 - h. Provide vandal resistant lenses for passive infrared (PIR) and dual technology wall switch occupancy sensors.
 2. Passive Infrared (PIR) Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.
 3. Ultrasonic Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 400 square feet.
 4. Passive Infrared/Ultrasonic Dual Technology Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.

D. Wall Dimmer Occupancy Sensors:

1. General Requirements:
 - a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated dimming control capability, and no leakage current to load in off mode.
 - b. Operation: Field selectable to operate either as occupancy sensor (automatic on/off) or as vacancy sensor (manual-on/automatic off).
 - c. Manual-Off Override Control Capability: When used to turn off load while in automatic-on mode, unit to revert back to automatic mode after no occupant presence is detected during the delayed-off time interval.
 - d. Dimmer: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, and listed as complying with UL 1472; type and rating suitable for load controlled.
 - e. Provide field adjustable dimming preset for occupied state.
 - f. Provide fade-to-off operation to notify occupant of impending load turn-off.
 - g. Finish: Color to be selected.
2. Passive Infrared (PIR) Wall Dimmer Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.

E. Ceiling Mounted Occupancy Sensors:

1. All Ceiling Mounted Occupancy Sensors:
 - a. Description: Low profile occupancy sensors designed for ceiling installation.
 - b. Unless otherwise indicated or required to control the load indicated on drawings, provide low voltage units, for use with separate compatible accessory power packs.
 - c. Provide field selectable setting for disabling LED motion detector visual indicator.
 - d. Occupancy sensor to be field selectable as either manual-on/automatic-off or automatic on/off.
 - e. Finish: White unless otherwise indicated.
2. Passive Infrared (PIR) Ceiling Mounted Occupancy Sensors:
 - a. Standard Range Sensors: Capable of detecting motion within an area of 450 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
 - b. Extended Range Sensors: Capable of detecting motion within an area of 1,200 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
3. Ultrasonic Ceiling Mounted Occupancy Sensors:
 - a. Standard Range Sensors: Capable of detecting motion within an area of 500 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
 - b. Medium Range Sensors: Capable of detecting motion within an area of 1,000 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
 - c. Extended Range Sensors: Capable of detecting motion within an area of 2,000 square feet at a mounting height of 9 feet.
4. Passive Infrared/Ultrasonic Dual Technology Ceiling Mounted Occupancy Sensors:
 - a. Standard Range Sensors: Capable of detecting motion within an area of 450 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
 - b. Extended Range Sensors: Capable of detecting motion within an area of 1,200 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.

5. Passive Infrared/Acoustic Dual Technology Ceiling Mounted Occupancy Sensors:
 - a. Standard Range Sensors: Capable of detecting motion within an area of 450 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
 - b. Extended Range Sensors: Capable of detecting motion within an area of 1,200 square feet at a mounting height of 9 feet.
- F. Directional Occupancy Sensors:
 1. All Directional Occupancy Sensors: Designed for wall or ceiling mounting, with integral swivel for field adjustment of motion detection coverage.
 - a. Unless otherwise indicated or required to control the load indicated on drawings, provide low voltage units, for use with separate compatible accessory power packs.
 - b. Provide field selectable setting for disabling LED motion detector visual indicator.
 - c. Finish: White unless otherwise indicated.
 2. Passive Infrared (PIR) Directional Occupancy Sensors:
 - a. Standard Range Sensors: Capable of detecting motion within a distance of 40 feet at a mounting height of 10 feet.
 - b. Long Range Sensors: Capable of detecting motion within a distance of 80 feet at a mounting height of 10 feet.
 - c. High Bay Sensors: Capable of detecting motion within a distance of 50 feet at a mounting height of 30 feet.
 3. Passive Infrared/Ultrasonic Dual Technology Directional Occupancy Sensors: Capable of detecting motion within a distance of 40 feet at a mounting height of 10 feet.
- G. Power Packs for Low Voltage Occupancy Sensors:
 1. Description: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage occupancy sensors for switching of line voltage loads.
 2. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on drawings.
 3. Input Supply Voltage: Dual rated for 120/277 V ac.
 4. Load Rating: As required to control the load indicated on drawings.

2.3 OUTDOOR MOTION SENSORS

- A. Manufacturers:
 1. Hubbell Lighting, Inc; _____: www.hubbelllighting.com/#sle.
 2. Lithonia Lighting; _____: www.lithonia.com/#sle.
 3. WattStopper; _____: www.wattstopper.com/#sle.
 4. Substitutions: See Section 016000 - Product Requirements.
 5. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.
- B. Description: Factory-assembled wet location listed device suitable for wall or ceiling/eave mounting, with integral swivel for field adjustment of coverage, capable of detecting motion for automatic control of load indicated.

- C. Sensor Technology: Passive Infrared (PIR) designed to detect occupancy by sensing movement of thermal energy between zones.
- D. Operation: Unless otherwise indicated, motion sensor to turn load on when motion is detected and to turn load off when no motion is detected during an adjustable turn-off delay time interval.
- E. Turn-Off Delay: Field adjustable, with time delay settings available up to 15 minutes.
- F. Integral Photocell: For dusk to dawn operation.
- G. Manual Override: Activated by switching power off to unit and then back on.
- H. Load Rating: 1,000 W incandescent and fluorescent load at 120 V ac.
- I. Coverage: Capable of detecting motion within a distance of 50 feet at a mounting height of 8 feet, with a field of view of 270 degrees.
- J. Finish: Color to be selected.

2.4 OUTDOOR PHOTO CONTROLS

- A. Manufacturers:
 - 1. Intermatic, Inc; _____: www.intermatic.com/#sle.
 - 2. Tork, a division of NSI Industries LLC; _____: www.tork.com/#sle.
 - 3. Substitutions: See Section 016000 - Product Requirements.
 - 4. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.
- B. Stem-Mounted Outdoor Photo Controls:
 - 1. Description: Direct-wired photo control unit with threaded conduit mounting stem and field-adjustable swivel base, listed and labeled as complying with UL 773A.
 - 2. Housing: Weatherproof, impact resistant polycarbonate.
 - 3. Photo Sensor: Cadmium sulfide.
 - 4. Provide external sliding shield for field adjustment of light level activation.
 - 5. Light Level Activation: 1 to 5 footcandles turn-on and 3 to 1 turn-off to turn-on ratio with delayed turn-off.
 - 6. Voltage: As required to control the load indicated on the drawings.
 - 7. Failure Mode: Fails to the on position.
 - 8. Load Rating: As required to control the load indicated on the drawings.
 - 9. Provide accessory wall-mounting bracket where indicated or as required to complete installation.
- C. Locking Receptacle-Mounted Outdoor Photo Controls
 - 1. Description: Plug-in locking type photo control unit complying with ANSI C136.10 for mounting on a compatible receptacle, listed and labeled as complying with UL 773.

2. Housing: Weatherproof, impact resistant UV stabilized polypropylene, color to be selected.
3. Photo Sensor: Cadmium sulfide.
4. Light Level Activation: 1 to 3 footcandles turn-on and 1.5 to 1 turn-off to turn-on ratio with instant turn-on and delayed turn-off.
5. Voltage: As required to control the load indicated on the drawings.
6. Failure Mode: Fails to the on position.
7. Load Rating: As required to control the load indicated on the drawings.
8. Surge Protection: 160 joule metal oxide varistor.
9. Provide the following accessories where indicated or as required to complete installation:
 - a. Receptacle: Complying with ANSI C136.10.
 - b. Mounting Bracket.
 - c. Shorting Cap: Suitable for replacing locking photo control to complete circuit.

D. Button Type Outdoor Photo Controls

1. Description: Direct-wired photo control unit complying with ANSI C136.24 with weatherproof gasketed wall plate where required or indicated, listed and labeled as complying with UL 773A.
2. Housing: Weather resistant polycarbonate.
3. Photo Sensor: Cadmium sulfide.
4. Light Level Activation: 1 to 3 footcandles turn-on and 3 to 1 turn-off to turn-on ratio with delayed turn-off.
5. Voltage: As required to control the load indicated on the drawings.
6. Failure Mode: Fails to the on position.
7. Load Rating: As required to control the load indicated on the drawings.

2.5 DAYLIGHTING CONTROLS

A. Manufacturers:

1. Hubbell Control Solutions; _____: www.hubbell.com/hubbellcontrolsolutions/en/#sle.
2. Lutron Electronics Company, Inc; _____: www.lutron.com/#sle.
3. Sensor Switch Inc; _____: www.sensorswitch.com/#sle.
4. WattStopper; _____: www.wattstopper.com/#sle.
5. Substitutions: See Section 016000 - Product Requirements.
6. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

B. System Description: Control system consisting of photo sensors and compatible control modules and power packs, contactors, or relays as required for automatic control of load indicated according to available natural light; capable of integrating with occupancy sensors and manual override controls.

C. Daylighting Control Photo Sensors: Low voltage class 2 photo sensor units with output signal proportional to the measured light level and provision for zero or offset based signal.

1. Sensor Type: Filtered silicon photo diode.
2. Sensor Range:
 - a. Indoor Photo Sensors: 5 to 100 footcandles.
 - b. Outdoor Photo Sensors: 5 to 250 footcandles.
 - c. Atrium Photo Sensors: 200 to 2,500 footcandles.
 - d. Skylight Photo Sensors: 1,000 to 6,000 footcandles.
 - e. Open Loop Photo Sensors: 3 to 6,000 footcandles.
3. Finish: White unless otherwise indicated.
4. Where wired sensors are indicated, wireless sensors are acceptable provided that all components and wiring modifications necessary for proper operation are included.

2.6 LIGHTING CONTACTORS

- A. Manufacturers:
 1. ABB/GE; _____: www.electrification.us.abb.com/#sle.
 2. Eaton Corporation; _____: www.eaton.com/#sle.
 3. Rockwell Automation Inc; Allen-Bradley Products; _____: ab.rockwellautomation.com/#sle.
 4. Schneider Electric; Square D Products; _____: www.schneider-electric.us/#sle.
 5. Siemens Industry, Inc; _____: www.usa.siemens.com/#sle.
 6. Substitutions: See Section 016000 - Product Requirements.
- B. Description: Magnetic lighting contactors complying with NEMA ICS 2, and listed and labeled as complying with UL 60947-1 and UL 60947-4-1; noncombination type unless otherwise indicated; ratings, configurations and features as indicated on the drawings.
- C. Combination Contactors: NEMA ICS 2, Class A combination controllers with magnetic contactor(s) and externally operable disconnect.
 1. Disconnects: Circuit breaker type.
 - a. Provide externally operable handle with means for locking in the OFF position. Provide safety interlock to prevent opening the cover with the disconnect in the ON position with capability of overriding interlock for testing purposes.
 - b. Provide auxiliary interlock for disconnection of external control power sources where applicable.
- D. Short Circuit Current Rating:
 1. Provide contactors with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
- E. Enclosures:
 1. Comply with NEMA ICS 6.
 2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1 or Type 12.
 - b. Outdoor Locations: Type 3R or Type 4.
 3. Finish: Manufacturer's standard unless otherwise indicated.

2.7 ACCESSORIES

- A. Auxiliary Contacts:
 - 1. Comply with NEMA ICS 5.
 - 2. Provide number and type of contacts indicated or required to perform necessary functions, including holding (seal-in) circuit and interlocking, plus one normally open (NO) and one normally closed (NC) spare contact for each lighting contactor, minimum.
- B. Pilot Devices:
 - 1. Comply with NEMA ICS 5; heavy-duty type.
 - 2. Nominal Size: 30 mm.
 - 3. Pushbuttons: Unless otherwise indicated, provide momentary, non-illuminated type with flush button operator; normally open or normally closed as indicated or as required.
 - 4. Selector Switches: Unless otherwise indicated, provide maintained, non-illuminated type with knob operator; number of switch positions as indicated or as required.
 - 5. Indicating Lights: Push-to-test type unless otherwise indicated.
 - 6. Provide LED lamp source for indicating lights and illuminated devices.
- C. Control and Timing Relays:
 - 1. Comply with NEMA ICS 5.
 - 2. Provide number and type of relays indicated or required to perform necessary functions.
 - 3. Timing Relays: Electronic or pneumatic as indicated.
 - a. Adjustable Timing Range: As indicated on drawings.
- D. Fire-Rated Device Enclosures:
 - 1. Provide as required to preserve fire resistance rating of building elements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that openings for outlet boxes are neatly cut and will be completely covered by devices or wall plates.
- D. Verify that final surface finishes are complete, including painting.

- E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to lighting control devices.
- F. Verify that the service voltage and ratings of lighting control devices are appropriate for the service voltage and load requirements at the location to be installed.
- G. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

- A. Install lighting control devices in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Install lighting control relays furnished under Section 253626
- C. Coordinate locations of outlet boxes provided under Section 260533.16 as required for installation of lighting control devices provided under this section.
 - 1. Mounting Heights: Unless otherwise indicated, as follows:
 - a. Wall Switch Occupancy Sensors: 48 inches above finished floor.
 - 2. Orient outlet boxes for vertical installation of lighting control devices unless otherwise indicated.
 - 3. Locate wall switch occupancy sensors on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
- D. Install lighting control devices in accordance with manufacturer's instructions.
- E. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- F. Install lighting control devices plumb and level, and held securely in place.
- G. Where required and not furnished with lighting control device, provide wall plate in accordance with Section 262726.
- H. Provide required supports in accordance with Section 260529.

- I. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- J. Identify lighting control devices in accordance with Section 260553.
- K. Occupancy Sensor Locations:
 - 1. Location Adjustments: Within the design intent, reasonably minor adjustments to locations may be made in order to optimize coverage and avoid conflicts or problems affecting coverage.
 - 2. Locate ultrasonic and dual technology passive infrared/ultrasonic occupancy sensors a minimum of 4 feet from air supply ducts or other sources of heavy air flow and as per manufacturer's recommendations, in order to minimize false triggers.
- L. Outdoor Photo Control Locations:
 - 1. Where possible, locate outdoor photo controls with photo sensor facing north. If north facing photo sensor is not possible, install with photo sensor facing east, west, or down.
 - 2. Locate outdoor photo controls so that photo sensors do not face artificial light sources, including light sources controlled by the photo control itself.
- M. Install outdoor photo controls so that connections are weatherproof. Do not install photo controls with conduit stem facing up in order to prevent infiltration of water into the photo control.
- N. Daylighting Control Photo Sensor Locations:
 - 1. Location Adjustments: Within the design intent, reasonably minor adjustments to locations may be made in order to optimize control and avoid conflicts or problems affecting proper detection of light levels.
 - 2. Unless otherwise indicated, locate photo sensors for closed loop systems to accurately measure the light level controlled at the designated task location, while minimizing the measured amount of direct light from natural or artificial sources such as windows or pendant luminaires.
 - 3. Unless otherwise indicated, locate photo sensors for open loop systems to accurately measure the level of daylight coming into the space, while minimizing the measured amount of lighting from artificial sources.
- O. Combination Enclosed Lighting Contactors:
 - 1. Except where indicated to be mounted adjacent to the equipment they supply, mount lighting contactors such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- P. Unless otherwise indicated, install power packs for lighting control devices above accessible ceiling or above access panel in inaccessible ceiling near the sensor location.

- Q. Unless otherwise indicated, install switches on load side of power packs so that switch does not turn off power pack.

3.4 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect each lighting control device for damage and defects.
- C. Test occupancy sensors to verify proper operation, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area. Record test results in written report to be included with submittals.
- D. Test outdoor photo controls to verify proper operation, including time delays where applicable.
- E. Test daylighting controls to verify proper operation, including light level measurements and time delays where applicable. Record test results in written report to be included with submittals.
- F. Correct wiring deficiencies and replace damaged or defective lighting control devices.

3.5 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.
- B. Adjust occupancy sensor settings to minimize undesired activations while optimizing energy savings, and to achieve desired function as indicated or as directed by Architect.
- C. Adjust position of directional occupancy sensors and outdoor motion sensors to achieve optimal coverage as required.
- D. Where indicated or as directed by Architect, install factory masking material or adjust integral blinders on passive infrared (PIR) and dual technology occupancy sensor lenses to block undesired motion detection.
- E. Adjust external sliding shields on outdoor photo controls under optimum lighting conditions to achieve desired turn-on and turn-off activation as indicated or as directed by Architect.
- F. Adjust daylighting controls under optimum lighting conditions after all room finishes, furniture, and window treatments have been installed to achieve desired operation as indicated or as directed by Architect. Record settings in written report to be included with submittals. Readjust controls calibrated prior to installation of final room finishes, furniture, and window treatments that do not function properly as determined by Architect.

3.6 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals, for closeout submittals.
- B. See Section 017900 - Demonstration and Training, for additional requirements.
- C. Demonstration: Demonstrate proper operation of lighting control devices to Architect, and correct deficiencies or make adjustments as directed.
- D. Training: Train Owner's personnel on operation, adjustment, programming, and maintenance of lighting control devices.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two hours of training.
 - 3. Instructor: Qualified contractor familiar with the project and with sufficient knowledge of the installed lighting control devices.
 - 4. Location: At project site.

END OF SECTION 260923

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SECTION 260924 – DISTRIBUTED LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Distributed Digital Lighting Control System: System includes
 - 1. Digital Lighting and Plug Load Controls
 - 2. Relay Panels
 - 3. Emergency Lighting Control.

1.2 RELATED SECTIONS

- A. Section 27 0539 - Surface Raceways for Communications Systems
- B. Section 26 5100 – Interior Lighting.
- C. Section 23 0993 – HVAC Control Sequence - Integrated Automation, Building integrator shall provide integration of the lighting control system with Building Automation Systems.

1.3 REFERENCES

- A. NFPA 70 - National Electrical Code; National Fire Protection Association.
- B. NEMA - National Electrical Manufacturers Association
- C. FCC emission standards
- D. UL - Underwriters Laboratories, Inc. Listings
- E. UL 2043 - Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products Installed in Air-Handling Spaces.
- F. UL 20 - General Use Switches, Plug Load Controls
- G. UL 924 - Standard for Emergency Lighting and Power Equipment
- H. ULC - Underwriter Laboratories of Canada Listings

1.4 DESIGN / PERFORMANCE REQUIREMENTS

- A. Digital Lighting Management System shall accommodate the square-footage coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors, switches, daylighting sensors and accessories that suit the required lighting and electrical system parameters.

- B. System shall conform to requirements of NFPA 70.
- C. System shall comply with FCC emission standards specified in part 15, sub-part J for commercial and residential application.
- D. System shall be listed under UL sections 916 and/or 508.

1.5 SUBMITTALS

- A. Submit under provisions of Section 01 3000 - Administrative Requirements.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Catalog sheets and specifications.
 - 2. Ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.
 - 3. Storage and handling requirements and recommendations.
 - 4. Installation instructions.
- C. Shop Drawings: Wiring diagrams a for the various components of the System specified including:
 - 1. Composite wiring and/or schematic diagram of each control circuit as proposed to be installed.
 - 2. Show location of all devices, including at minimum sensors, load controllers, and switches/dimmers for each area on reflected ceiling plans.
 - 3. Provide room/area details including products and sequence of operation for each room or area. Illustrate typical acceptable room/area connection topologies.
 - 4. Network riser diagram including floor and building level details. Include network cable specification. Illustrate points of connection to integrated systems. Coordinate integration with mechanical and/or other trades.
- D. Manufacturer's Certificates: Certify products meet or exceed specified requirements.
- E. Closeout Submittals:
 - 1. Project Record Documents: Record actual installed locations and settings for lighting control devices.
 - 2. Operation and Maintenance Manual:
 - a. Include approved Shop Drawings and Product Data.
 - b. Include Sequence of Operation, identifying operation for each room or space.
 - c. Include manufacturer's maintenance information.
 - d. Operation and Maintenance Data: Include detailed information on device programming and setup.
 - e. Include startup and test reports.

- F. Title 24 Acceptance Testing Documentation: Submit Certification of Acceptance and associated documentation for lighting control acceptance testing performed in accordance with CAL TITLE 24 P6, as specified in Part 3 of this specification under "COMMISSIONING".

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing of centralized and distributed lighting control systems with a minimum of 10 years documented experience.
- B. Installer Qualifications: Company certified by the manufacturer and specializing in installation of networked lighting control products with minimum three years documented experience.
- C. System Components: Demonstrate that individual components have undergone quality control and testing prior to shipping.

1.7 PRE-INSTALLATION MEETINGS

- A. Convene minimum two weeks prior to commencing Work of this section. Meeting to be attended by Contractor, Architect, system installer, factory authorized manufacturer's representative, and representative of all trades related to the system installation.
- B. Review installation procedures and coordination required with related Work and the following:
 - 1. Confirm the location and mounting of all devices, with special attention to placement of switches, dimmers, and any sensors.
 - 2. Review the specifications for low voltage control wiring and termination.
 - 3. Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.
 - 4. Discuss requirements for integration with other trades
- C. Inspect and make notes of job conditions prior to installation:
 - 1. Record minutes of the conference and provide copies to all parties present.
 - 2. Identify all outstanding issues in writing designating the responsible party for follow-up action and the timetable for completion.
 - 3. Installation shall not begin until all outstanding issues are resolved to the satisfaction of the Architect.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.9 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
- B. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
 - 1. Ambient temperature: 32 to 104 degrees F (0 to 40 degrees C).
 - 2. Relative humidity: Maximum 90 percent, non-condensing.

1.10 WARRANTY

- A. Manufacturer shall provide a 5 year limited warranty on products within this installation, except where otherwise noted, and consisting of a one for one device replacement.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer: WattStopper, which is located at: 2700 Zanker Rd., Suite 168; San Jose, CA 95134; Tel: 408.988.5331; Fax: 408.988.5373; Email: [request info \(\)](mailto:request_info@wattstopper.com); Web: www.wattstopper.com
- B. Substitutions: Acquity NLight, Lutron
- C. Requests for substitutions will be considered in accordance with provisions of Section 01 6000 - Product Requirements.

2.2 DISTRIBUTED DIGITAL LIGHTING CONTROL SYSTEM

- A. System General: Provide a WattStopper Digital Lighting Management System (DLM) complete with all necessary enclosures, wiring, and system components to ensure a complete and properly functioning system as indicated on the Drawings and specified herein. If a conflict is identified, between the Drawing and this Specification, contact the Architect for clarification prior to proceeding.
 - 1. Space Control Requirements: Provide occupancy/vacancy sensors with Manual- or Partial-ON functionality as indicated in all spaces except toilet rooms, storerooms, library stacks, or other applications where hands-free operation is desirable and Automatic-ON occupancy sensors are more appropriate. Provide Manual-ON occupancy/vacancy sensors for any enclosed office, conference room, meeting room, open plan system and training room.
 - 2. Daylit Areas: Provide daylight-responsive automatic control in all spaces (conditioned or unconditioned) where daylight contribution is available as defined by relevant local building energy code or as indicated on drawings:

- a. All luminaires within code-defined daylight zones shall be controlled separately from luminaires outside of daylight zones.
 - b. Daytime setpoints for total ambient illumination (combined daylight and electric light) levels that initiate dimming shall be programmed in compliance with relevant local building energy codes.
 - c. Multiple-level switched daylight harvesting controls may be utilized for areas marked on drawings.
 - d. Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system may be designed to turn off electric lighting when daylight is at or above required lighting levels, only if system functions to turn lamps back on at dimmed level, rather than turning full-on prior to dimming.
3. Conference, meeting, training, auditoriums, and multipurpose rooms shall have controls that allow for independent control of each local control zone. Rooms larger than 300 square feet shall instead have at least four preset lighting scenes unless otherwise specified. Occupancy / vacancy sensors shall be provided to turn off all lighting in the space. Spaces with up to four moveable walls shall include controls that can be reconfigured when the room is partitioned.
- B. Equipment Required: Lighting Control and Automation system as defined under this section covers the following equipment.
1. Digital Lighting Management (DLM) local network: Free topology, plug-in wiring system (Cat 5e) for power and data to room devices.
 2. Digital Room Controllers: Self-configuring, digitally addressable one, two or three relay plenum-rated controllers for on/off control. Selected models include 0-10 volt or line voltage forward phase control dimming outputs and integral current monitoring capabilities.
 3. Digital Fixture Controllers: Self-configuring, digitally addressable one relay fixture-integrated controllers for on/off/0-10V dimming control.
 4. Digital Occupancy Sensors: Self-configuring, digitally addressable, calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.
 5. Digital Switches: Self-configuring, digitally addressable pushbutton on/off, dimming, and scene switches with two-way active infrared (IR) communications.
 6. Digital Daylighting Sensors: Single-zone closed loop, multi-zone open loop and single-zone dual-loop daylighting sensors with two-way active infrared (IR) communications for daylight harvesting using switching, bi-level, tri-level or dimming control.
 7. Configuration Tools: Handheld remote for room configuration and relay panel programming provides two way infrared (IR) communications to digital devices and allows complete configuration and reconfiguration of the device / room from up to 30 feet away.
 8. Digital Lighting Management (DLM) segment network: Linear topology, BACnet MS/TP network (1.5 twisted pair, shielded) to connect multiple DLM local networks for centralized control.

9. Network Bridge: Provides BACnet MS/TP-compliant digital networked communication between rooms, panels and the Segment Manager or building automation system (BAS) and automatically creates BACnet objects representative of connected devices.
 10. Wireless Network Bridge and Border Router: Provides Wireless Network Bridges that automatically create BACnet objects for all DLM devices on their local network (room) and communicate that information over a standalone wireless mesh 6LoWPAN network to a Border Router. The Border Router manages the formation and communication of the mesh network, and provides an ethernet network connection to upstream intelligent devices, such as a Segment Manager.
 11. Segment Manager: BACnet MS/TP-based controller with web browser-based user interface for system control, scheduling, power monitoring, room device parameter administration and reporting.
 12. Programming and Configuration Software: Optional PC-native application capable of accessing DLM control parameters within a room, for the local network, via a USB adapter, or globally, for many segment networks simultaneously, via BACnet/IP communication.
 13. Digital Lighting Management Relay Panel and Zone Controller: Provides up to 8, 24, or 48 mechanically latching relays. Relays include a manual override and a single push-on connector for easy installation or removal from the panel. Panel accepts program changes from handheld configuration tool for date and time, location, holidays, event scheduling, button binding and group programming. Provides BACnet MS/TP-compliant digital networked communication between other lighting controls and/or building automation system (BAS). Zero relay Zone Controller primarily supports Digital Fixture Controller applications.
 14. Emergency Lighting Control Unit (ELCU): Allows a standard lighting control device to control emergency lighting in conjunction with normal lighting in any area within a building
- C. Local Network LMRJ-Series: DLM local network is a free topology lighting control physical connection and communication protocol designed to control a small area of a building.
1. Features of the DLM local network include:
 - a. Plug n' Go automatic configuration and binding of occupancy sensors, switches and lighting loads to the most energy-efficient sequence of operation based upon the device attached.
 - b. Simple replacement of any device in the local DLM network with a standard off the shelf unit without requiring significant commissioning, configuration or setup.
 - c. Push n' Learn configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices in the local network.
 - d. Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30 feet from a sensor, wall switch or IR receiver.

2. Digital room devices connect to the local network using pre-terminated Cat 5e cables with RJ-45 connectors, which provide both data and power to room devices. Systems that utilize RJ-45 patch cords but do not provide serial communication data from individual end devices are not acceptable.
3. If manufacturer's pre-terminated Cat5e cables are not used for the installation each cable must be individually tested and observed by authorized service representative following installation.

2.3 DIGITAL LOAD CONTROLLERS (ROOM AND FIXTURE CONTROLLERS)

- A. Digital Load Controllers: Digital controllers for lighting zones, fixtures and/or plug loads automatically bind room loads to the connected control devices in the space without commissioning or the use of any tools. Provide controllers to match the room lighting control requirements. Controllers are simple to install, and do not have dip switches/potentiometers, or require special configuration for standard Plug n' Go applications. Control units include the following features
1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
 2. Simple replacement using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf device.
 3. Multiple room controllers connected together in a local network must automatically arbitrate with each other, without requiring any configuration or setup, so that individual load numbers are assigned starting with load 1 to a maximum of 64, assigned based on each controller's device ID's from highest to lowest.
 4. Device Status LEDs to indicate:
 - a. Data transmission
 - b. Device has power
 - c. Status for each load
 - d. Configuration status
 5. Quick installation features including:
 - a. Standard junction box mounting
 - b. Quick low voltage connections using standard RJ-45 patch cable
 6. Based on individual configuration, each load shall be capable of the following behavior on power up following the loss of normal power:
 - a. Turn on to 100 percent
 - b. Turn off
 - c. Turn on to last level
 7. Each load be configurable to operate in the following sequences based on occupancy:
 - a. Auto-on/Auto-off (Follow on and off)
 - b. Manual-on/Auto-off (Follow off only)
 8. Polarity of each load output shall be reversible, via digital configuration, so that on is off and off is on.
 9. BACnet object information shall be available for the following objects:
 - a. Load status
 - b. Schedule state, normal or after-hours
 - c. Demand Response enable and disable
 - d. Room occupancy status

- e. Total room lighting and plug loads watts
- f. Electrical current
- g. Total watts per controller
- h. Total room watts/sq ft.
- i. Force on/off all loads
- 10. UL 2043 plenum rated
- 11. Manual override and LED indication for each load
- 12. Zero cross circuitry for each load
- 13. All digital parameter data programmed into an individual room controller or plug load controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.
- 14. Dimming Room Controllers shall share the following features:
 - a. Each load shall have an independently configurable preset on level for Normal Hours and After Hours events to allow different dimmed levels to be established at the start of both Normal Hours and After Hours events.
 - b. Fade rates for dimming loads shall be specific to bound switch buttons, and the load shall maintain a default value for any bound buttons that do not specify a unique value.
 - c. The following dimming attributes may be changed or selected using a wireless configuration tool:
 - 1) Establish preset level for each load from 0-100 percent
 - 2) Set high and low trim for each load
 - d. Override button for each load provides the following functions:
 - 1) Press and release for on/off control
 - 2) Press and hold for dimming control
 - e. Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected driver. LED level indicators on bound dimming switches shall utilize this new maximum and minimum trim.
 - f. Each dimming output channel shall have an independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0-100 percent dimming range defined by the minimum and maximum calibration trim.
 - g. Calibration and trim levels must be set per output channel. Devices that set calibration or trim levels per controller (as opposed to per load) are not acceptable.
 - h. All configuration shall be digital. Devices that set calibration or trim levels per output channel via trim pots or dip-switches are not acceptable.

B. On/Off Room Controllers shall include:

- 1. Dual voltage (120/277 VAC, 60 Hz) capable rated for 20A total load
- 2. One or two relay configuration
- 3. Simple 150 mA switching power supply (Only 4 100 series devices on a Cat 5e local network)
- 4. Three RJ-45 DLM local network ports with integral strain relief and dust cover
- 5. WattStopper product numbers: LMRC-101, LMRC-102

C. On/Off/0-10V Dimming Enhanced Room Controllers shall include:

1. Dual voltage (120/277 VAC, 60 Hz) capable or 347 VAC, 60 Hz. 120/277 volt models rated for 20A total load; 347 volt models rated for 15A total load
2. Built in real time current monitoring
3. One, two or three relays configurations
4. Smart 250 mA switching power supply
5. Four RJ-45 DLM local network ports. Provide integral strain relief
6. One dimming output per relay
 - a. 0-10V Dimming - Where indicated, one 0-10 volt analog output per relay for control of compatible ballasts and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Room Controller to assure full light output from the controlled lighting (LMRC-110 series and 210 series).
7. WattStopper product numbers: LMRC-211, LRMC-212, LRMC-213.

D. On/Off/ Forward Phase Dimming Room Controllers shall include:

1. Dual voltage (120/277 VAC, 60 Hz) rated for 20A total load, with forward phase dimmed loads derating to 16A for some load types
2. Built in real time current monitoring
3. One or two relays configurations
4. Smart 250 mA switching power supply
5. Four RJ-45 DLM local network ports. Provide integral strain relief
6. One dimming output per relay
 - a. Line Voltage, Forward Phase Dimming - Where indicated, one forward phase control line voltage dimming output per relay for control of compatible two-wire or three-wire ballasts, LED drivers, MLV, forward phase compatible ELV, neon/cold cathode and incandescent loads. (LMRC-220 series)
7. WattStopper product numbers: LMRC-221, LMRC-222

E. Fixture Controllers shall include

1. A form factor and product ratings to allow various OEM fixture manufacturers to mount the device inside the ballast/driver cavity of standard-sized fluorescent or LED general lighting fixtures.
2. One 3A 120/277V rated mechanically held relay.
3. Programmable behavior on power up following the loss of normal power:
 - a. Turn on to 100 percent
 - b. Turn off
 - c. Turn on to last level
4. Requirement for 7 mA of 24VDC operating power from the DLM local network.
5. Fixture Controller does not require a connection to a neutral conductor to operate, and unlike other types of Load Controllers it does not contribute power to the DLM local network to drive accessory devices.
6. Power to drive the LMFC Fixture Controller electronics can come from any Room or Plug Load Controller, LMPB-100 Power Booster and/or LMZC-301 Zone Controller

7. 0-10V dimming capability via a single 0-10 volt analog output from the device for control of compatible ballasts and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Fixture Controller.
8. Connect to a single or dual RJ-45 adaptor with 24 inch leads. Single adaptor mounts in a 1/2 inch KO and dual adaptor in a 2.2 by 1.32 inch rectangular hole for connection to the DLM local network.
9. Adaptor leads are insulated for use in a fixture cavity, and the lead length allows the OEM fixture manufacturer flexibility to position the Fixture Controller and the RJ45 jack in the best locations on each fixture.
10. A complete set of dimming features described above in the paragraph detailing On/Off/Dimming Enhanced Room Controllers.
 - a. WattStopper product numbers: Fixture Controller: LMFC-011, DLM Cable Connector: LMFC-RJ-50-24 or LMFC-2RJ, Power Booster: LMPB-100.

2.4 DIGITAL WALL OR CEILING MOUNTED WIRELESS OCCUPANCY SENSOR

- A. Digital Occupancy Sensors shall provide digital calibration and electronic documentation. Features include the following:
 1. Digital calibration for the following variables:
 - a. Sensitivity, 0-100 percent in 10 percent increments
 - b. Time delay, 1-30 minutes in 1 minute increments
 - c. Test mode, Five second time delay
 - d. Detection technology, PIR, Ultrasonic or Dual Technology activation and/or re-activation.
 - e. Walk-through mode
 2. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
 3. Programmable control functionality including:
 - a. Each sensor may be programmed to control specific loads within a local network.
 - b. Sensor shall be capable of activating one of 16 user-definable lighting scenes.
 - c. Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically within a configurable period of time (default 10 seconds) after turning off.
 - d. On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
 - e. Ultrasonic and Passive Infrared
 - f. Ultrasonic or Passive Infrared
 - g. Ultrasonic only
 - h. Passive Infrared only
 - i. Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.
 4. Wireless connection to DLM local network.

5. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
 6. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
 7. Manual override of controlled loads.
 8. All digital parameter data programmed into an individual occupancy sensor shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.
 9. Operation on an included CR123A battery providing a 10+ year lifespan.
- B. BACnet object information shall be available for the following objects:
1. Detection state
 2. Occupancy sensor time delay
 3. Occupancy sensor sensitivity, PIR and Ultrasonic
- C. Units shall not have any dip switches or potentiometers for field settings
- D. WattStopper product numbers: LMPX,LMPC

2.5 DIGITAL WALL SWITCH OCCUPANCY SENSORS

- A. Digital Occupancy Sensors shall provide scrolling LCD display for digital calibration and electronic documentation. Features include the following:
1. Digital calibration and pushbutton configuration for the following variables:
 - a. Sensitivity: 0-100 percent in 10 percent increments
 - b. Time delay: 1-30 minutes in 1 minute increments
 - c. Test mode: Five second time delay
 - d. Detection technology: PIR, Dual Technology activation and/or re-activation.
 - e. Walk-through mode
 - f. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
 2. Programmable control functionality including:
 - a. Each sensor may be programmed to control specific loads within a local network.
 - b. Sensor shall be capable of activating one of 16 user-definable lighting scenes.
 - c. Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically during the configurable period of time (default 10 seconds) after turning off.
 - d. On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
 - 1) Ultrasonic and Passive Infrared
 - 2) Ultrasonic or Passive Infrared
 - 3) Ultrasonic only
 - 4) Passive Infrared only

3. Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.
 4. Two RJ-45 ports for connection to DLM local network.
 5. Two-way infrared (IR) transceiver to allow remote programming through handheld configuration tool and control by remote personal controls.
 6. Device Status LEDs including
 - a. PIR detection
 - b. Ultrasonic detection
 - c. Configuration mode
 - d. Load binding
 7. Assignment of any occupancy sensor to a specific load within the room without wiring or special tools.
 8. Assignment of local buttons to specific loads within the room without wiring or special tools
 9. Manual override of controlled loads
 10. All digital parameter data programmed into an individual wall switch sensor shall be retained in non-volatile FLASH memory within the wall switch sensor itself. Memory shall have an expected life of no less than 10 years.
- B. BACnet object information shall be available for the following objects:
1. Detection state
 2. Occupancy sensor time delay
 3. Occupancy sensor sensitivity, PIR and Ultrasonic
 4. Button state
 5. Switch lock control
 6. Switch lock status
- C. Units shall not have any dip switches or potentiometers for field settings.
- D. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.
- E. Two-button wall switch occupancy sensors, when connected to a single relay dimming room or fixture controller, shall operate in the following sequence as a factory default:
1. Left button
 - a. Press and release - Turn load on
 - b. Press and hold - Raise dimming load
 2. Right button
 - a. Press and release - Turn load off
 - b. Press and hold - Lower dimming load
- F. Low voltage momentary pushbuttons shall include the following features:
1. Load/Scene Status LED on each switch button with the following characteristics:
 - a. Bi-level LED
 - b. Dim locator level indicates power to switch
 - c. Bright status level indicates that load or scene is active

2. The following button attributes may be changed or selected using a wireless configuration tool:
 - a. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
 - b. Individual button function may be configured to Toggle, On only or Off only.
 - c. Individual scenes may be locked to prevent unauthorized change.
 - d. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
 - e. Ramp rate may be adjusted for each dimmer switch.
 - f. Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependent; each button may be bound to multiple loads.
 - g. WattStopper part numbers: LMPW, LMDW. Available in white, light almond, ivory, grey, red and black; compatible with wall plates with decorator opening.

2.6 DIGITAL WALL SWITCHES

- A. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration. Wall switches shall include the following features:

1. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
3. Configuration LED on each switch that blinks to indicate data transmission.
4. Load/Scene Status LED on each switch button with the following characteristics:
 - a. Bi-level LED
 - b. Dim locator level indicates power to switch
 - c. Bright status level indicates that load or scene is active
 - d. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.
5. Programmable control functionality including:
 - a. Button priority may be configured to any BACnet priority level, from 1-16, corresponding to networked operation allowing local actions to utilize life safety priority
 - b. Scene patterns may be saved to any button other than dimming rockers. Once set, buttons may be digitally locked to prevent overwriting of the preset levels.
6. All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the wall switch itself. Memory shall have an expected life of no less than 10 years.

- B. BACnet object information shall be available for the following objects:

1. Button state
2. Switch lock control
3. Switch lock status

- C. Two RJ-45 ports for connection to DLM local network.
- D. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration shall be required to achieve multi-way switching.
- E. Load and Scene button function may be reconfigured for individual buttons from Load to Scene, and vice versa.
 - 1. Individual button function may be configured to Toggle, On only or Off only.
 - 2. Individual scenes may be locked to prevent unauthorized change.
 - 3. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
 - 4. Ramp rate may be adjusted for each dimmer switch.
 - 5. Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependent; each button may be bound to multiple loads.
 - 6. WattStopper product numbers: LMSW-101, LMSW-102, LMSW-103, LMSW-104, LMSW-105, LMSW-108, LMDM-101. Available in white, light almond, ivory, grey, red and black; compatible with wall plates with decorator opening.

2.7 DIGITAL DAYLIGHTING SENSORS

- A. Digital daylighting sensors shall work with load controllers and relay panels to provide automatic switching, bi-level, or tri-level or dimming daylight harvesting capabilities for any load type connected to the controller or panel. Daylighting sensors shall be interchangeable without the need for rewiring.
 - 1. Closed loop sensors measure the ambient light in the space and control a single lighting zone.
 - 2. Open loop sensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones.
 - 3. Dual loop sensors measure both ambient and incoming daylight in the space to insure that proper light levels are maintained as changes to reflective materials are made in a single zone
- B. Digital daylighting sensors shall include the following features:
 - 1. Sensor's internal photodiode shall only measure lightwaves within the visible spectrum. The photodiode's spectral response curve shall closely match the entire photopic curve. Photodiode shall not measure energy in either the ultraviolet or infrared spectrums. Photocell shall have a sensitivity of less than 5 percent for any wavelengths less than 400 nanometers or greater than 700 nanometers.
 - 2. Sensor light level range shall be from 1-6,553 foot-candles (fc).
 - 3. Capability of ON/OFF, bi-level or tri-level switching, or dimming, for each controlled zone, depending on the selection of load controller(s) and load binding to controller(s).
 - 4. For switching daylight harvesting, the photosensor shall provide a field-selectable deadband, or a separation, between the "ON Setpoint" and the "OFF Setpoint" that will prevent the lights from cycling excessively after they turn off.

5. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a field-selectable minimum level.
6. Photosensors shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.
7. Photosensors shall provide adjustable cut-off time. Cut-off time is defined by the number of selected minutes the load is at the minimum output before the load turns off. Selectable range between 0-240 minutes including option to never cut-off.
8. Optional wall switch override shall allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise lighting levels for a selectable period of time or cycle of occupancy.
9. Integral infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool, and for communication with personal remote controls.
10. Configuration LED status light on device that blinks to indicate data transmission.
11. Status LED indicates test mode, override mode and load binding.
12. Recessed switch on device to turn controlled load(s) ON and OFF.
13. BACnet object information shall be available for the following daylighting sensor objects, based on the specific photocell's settings:
 - a. Light level
 - b. Day and night setpoints
 - c. Off time delay
 - d. On and off setpoints
 - e. Up to three zone setpoints
 - f. Operating mode - on/off, bi-level, tri-level or dimming
14. One RJ-45 port for connection to DLM local network.
15. A choice of accessories to accommodate multiple mounting methods and building materials. Photosensors may be mounted on a ceiling tile, skylight light well, suspended lighting fixture or backbox. Standard tube photosensors accommodate mounting materials from 0-0.62 inch thick (LMLS-400, LMLS-500). Extended tube photosensors accommodate mounting materials from 0.62 to 1.25 inches thick (LMLS-400-L, LMLS-500-L). Mounting brackets are compatible with J boxes (LMLS-MB1) and wall mounting (LMLS-MB2). LMLS-600 photosensor to be mounted on included bracket below skylight well.
16. Any load or group of loads in the room can be assigned to a daylighting zone
17. Each load within a daylighting zone can be individually enabled or disabled for discrete control (load independence).
18. All digital parameter data programmed into a photosensor shall be retained in non-volatile FLASH memory within the photosensor itself. Memory shall have an expected life of no less than 10 years.

C. Closed loop digital photosensors shall include the following additional features:

1. An internal photodiode that measures light in a 100-degree angle, cutting off the unwanted light from bright sources outside of this cone.
2. Automatic self-calibration, initiated from the photosensor, a wireless configuration tool or a PC with appropriate software.

3. Automatically establishes application-specific setpoints following self-calibration. For switching operation, an adequate deadband between the ON and OFF setpoints shall prevent the lights from cycling; for dimming operation a sliding setpoint control algorithm with separate Day and Night setpoints shall prevent abrupt ramping of loads.
 4. WattStopper Product Number: LMLS-400, LMLS-400-L.
- D. Open loop digital photosensors shall include the following additional features:
1. An internal photodiode that measures light in a 60-degree angle (cutting off the unwanted light from the interior of the room).
 2. Automatically establishes application-specific setpoints following manual calibration using a wireless configuration tool or a PC with appropriate software. For switching operation, an adequate deadband between the ON and OFF setpoints for each zone shall prevent the lights from cycling; for dimming operation, a proportional control algorithm shall maintain the design lighting level in each zone.
 3. Each of the three discrete daylight zones can include any non overlapping group of loads in the room.
 4. WattStopper Product Number: LMLS-500, LMLS-500-L.
- E. Dual loop digital photosensors shall include the following additional features:
1. Close loop portion of dual loop device must have an internal photodiode that measures light in a 100 degree angle, cutting off the unwanted light from sources outside of this con
 2. Open loop portion of dual loop device must have an internal photodiode that can measure light in a 60 degree angle, cutting off the unwanted light from the interior of the room.
 3. Automatically establishes application-specific set-points following self-calibration. For switching operation, an adequate deadband between the ON and OFF setpoints shall prevent the lights from cycling; for dimming operation a sliding setpoint control algorithm with separate Day and Night setpoints shall prevent abrupt ramping of load.
 4. Device must reference closed loop photosensor information as a base line reference. The device must be able to analyze the open loop photosensor information to determine if an adjustment in light levels is required.
 5. Device must be able to automatically commission setpoints each night to provide adjustments to electrical lighting based on changes in overall lighting in the space due to changes in reflectance within the space or changes to daylight contribution based on seasonal changes.
 6. Device must include extendable mounting arm to properly position sensor within a skylight well.
 7. WattStopper product number LMLS-600

2.8 DIGITAL PARTITION CONTROLS

- A. Partition controls shall enable manual or automatic coordination of lighting controls in flexible spaces with up to four moveable walls by reconfiguring the connected digital switches and occupancy sensors.
- B. Four-button low voltage pushbutton switch for manual control.
 - 1. Two-way infrared (IR) transceiver for use with configuration remote control.
 - 2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
 - 3. Configuration LED on each switch that blinks to indicate data transmission.
 - 4. Each button represents one wall; Green button LED indicates status.
 - 5. Two RJ-45 ports for connection to DLM local network.
 - 6. WattStopper part number: LMPS-104. Available in white, light almond, ivory, grey and black; compatible with wall plates with decorator opening.
- C. Coordinate contact closure interface for automatic control via input from limit switches on movable walls specified in Section 10 22 43 - Sliding Partitions .
 - 1. Operates on Class 2 power supplied by DLM local network.
 - 2. Includes 24VDC output and four input terminals for maintained third party contract closure inputs.
 - 3. Input max. sink/source current: 1-5mA
 - 4. Logic input signal voltage High: > 18VDC
 - 5. Logic input signal voltage Low: < 2VDC
 - 6. Four status LEDs under hinged cover indicate if walls are open or closed; supports LMPS-104 as remote status indicator.
 - 7. Two RJ-45 ports for connection to DLM local network.
 - 8. WattStopper part number: LMIO-102

2.9 HANDHELD CONFIGURATION TOOLS

- A. Provide a wireless configuration tool to facilitate customization of DLM local networks using two-way infrared communications, and/or PC software that connects to each local network via a USB interface.
- B. Features and functionality of the wireless configuration tool shall include but not be limited to:
 - 1. Two-way infrared (IR) communication with DLM IR-enabled devices within a range of approximately 30 feet.
 - 2. High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation.
 - 3. Must be able to read and modify parameters for load controllers and relay panels, occupancy sensors, wall switches, daylighting sensors, network bridges, and identify DLM devices by type and serial number.

4. Save up to eight occupancy sensor setting profiles, and apply profiles to selected sensors.
5. Temporarily adjust light level of any load(s) on the local network, and incorporate those levels in scene setting. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.
6. Adjust or fine-tune daylighting settings established during auto-configuration, and input light level data to complete configuration of open loop daylighting controls.
7. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.
8. Verify status of building level network devices.

C. WattStopper Product Numbers: Handheld LMCT-100

2.10 DLM SEGMENT NETWORK

- A. Provide a segment network using linear topology, BACnet-based MS/TP subnet to connect DLM local networks (rooms) and LMCP relay panels for centralized control.
1. Each connected DLM local network shall include a single network bridge (LMBC-300), and the network bridge is the only room-based device that is connected to the segment network.
 2. Network bridges, relay panels and segment managers shall include terminal blocks, with provisions for separate "in" and "out" terminations, for segment network connections.
 3. Segment network utilizes 1.5 twisted pair, shielded, cable supplied by the lighting control manufacturer. Maximum cable run for each segment is 4,000 feet. Conductor-to-conductor capacitance of the twisted pair shall be less than 30 pf/ft and have a characteristic impedance of 120 Ohms.
 4. Network wire jacket is available in high visibility green, white, or black.
 5. Substitution of manufacturer-supplied cable is not permitted and may void the warranty, if non-approved cable is installed, and if terminations are not completed according to manufacturer's specific requirements.
 6. Network signal integrity requires that each conductor and ground wire be correctly terminated at every connected device.
 7. Segment networks shall be capable of connecting to any of the following: BACnet-compliant BAS (provided by others) directly via MS/TP, or BACnet/IP via an NB-ROUTER or LMSM Unit. Systems whose room-connected network infrastructure require gateway devices to provide BACnet data to a BAS are unacceptable
- B. WattStopper Product Number: LM-MSTP, LM-MSTP-W, LM-MSTP-B, LM-MSTP-DB

2.11 NETWORK BRIDGE

- A. Network bridge module connects a DLM local network to a BACnet-compliant segment network for communication between rooms, relay panels and a segment manager or BAS. Each local network shall include a network bridge component to provide a connection to the local network room devices. Network bridge shall use industry standard BACnet MS/TP network communication and an optically isolated EIA/TIA RS-485 transceiver.

1. Network bridge shall be provided as a separate module connected on the local network through an available RJ-45 port.
2. Provide Plug n' Go operation to automatically discover room devices connected to the local network and make all device parameters visible to the segment manager via the segment network. No commissioning shall be required for set up of the network bridge on the local network.
3. Network bridge shall automatically create standard BACnet objects for selected DLM devices to allow any BACnet-compliant BAS to include lighting control and power monitoring features as provided by the DLM devices on each local network. BACnet objects will be created for the addition or replacement of any given DLM device for the installed life of the system. Products requiring that an application-specific point database be loaded to create or map BACnet objects are not acceptable. Systems not capable of providing BACnet data for control devices via a dedicated BACnet Device ID and physical MS/TP termination per room are not acceptable. Standard BACnet objects shall be provided as follows:
 - a. Read/write the normal or after hours schedule state for the room
 - b. Read the detection state of each occupancy sensor
 - c. Read the aggregate occupancy state of the room
 - d. Read/write the On/Off state of loads
 - e. Read/write the dimmed light level of loads
 - f. Read the button states of switches
 - g. Read total current in amps, and total power in watts through the load controller
 - h. Read/write occupancy sensor time delay, PIR sensitivity and ultrasonic sensitivity settings
 - i. Activate a preset scene for the room
 - j. Read/write daylight sensor fade time and day and night setpoints
 - k. Read the current light level, in foot-candles, from interior and exterior photosensors and photocells
 - l. Set daylight sensor operating mode
 - m. Read/write wall switch lock status
 - n. Read watts per square foot for the entire controlled room
 - o. Write maximum light level per load for demand response mode
 - p. Read/write activation of demand response mode for the room
 - q. Activate/restore demand response mode for the room

B. WattStopper product numbers: LMBC-300

2.12 WIRELESS NETWORK BRIDGES AND BORDER ROUTER

- A. Wireless Network Bridges connect to a DLM local network (room) and use IEEE 802.15.4 6LoWPAN for communication between rooms and to a Border Router that oversees the formation and configuration of the wireless network. Each local network shall include a wireless network bridge that connects to the other DLM devices on the local network, and a group of Wireless Bridges shall connect to a Border Router.
- B. Features of the Wireless Network Bridges shall be as follows:

1. Network bridge shall be provided as a separate module connected on the local network through an available RJ-45 port.
2. Wireless Bridges provide Plug n' Go operation to automatically discover room devices connected to the local network and make all device parameters visible to the Border Router via the wireless network. No commissioning shall be required for set up of the network bridge on the local network.
3. Wireless Bridges shall incorporate dual internal omni-directional antennas with diversity to provide wide and robust communication, and so the antennas will be protected against accidental contact with other objects in the space.
4. Two LEDs shall be included on the bridge to provide feedback about the local network (red) and wireless network (blue) health.
5. Wireless Network bridge shall automatically create standard BACnet objects for selected DLM devices to allow any BACnet-compliant BAS to include lighting control and power monitoring features as provided by the DLM devices on each local network. BACnet objects will be created for the addition or replacement of any given DLM device for the installed life of the system. Products requiring that an application-specific point database be loaded to create or map BACnet objects are not acceptable. Systems not capable of providing BACnet data for control devices via a dedicated BACnet Device ID per room are not acceptable. Standard BACnet objects shall be provided as follows:
 - a. Read/write the normal or after hours schedule state for the room
 - b. Read the detection state of each occupancy sensor
 - c. Read the aggregate occupancy state of the room
 - d. Read/write the On/Off state of loads
 - e. Read/write the dimmed light level of loads
 - f. Read the button states of switches
 - g. Read total current in amps, and total power in watts through the load controller
 - h. Read/write occupancy sensor time delay, PIR sensitivity and ultrasonic sensitivity settings
 - i. Activate a preset scene for the room
 - j. Read/write daylight sensor fade time and day and night setpoints
 - k. Read the current light level, in foot-candles, from interior and exterior photosensors and photocells
 - l. Set daylight sensor operating mode
 - m. Read/write wall switch lock status
 - n. Read watts per square foot for the entire controlled room
 - o. Write maximum light level per load for demand response mode
 - p. Read/write activation of demand response mode for the room
 - q. Activate/restore demand response mode for the room

C. Features of the Wireless Border Router shall be:

1. The Wireless Border Router shall manage the formation and configuration of the 6LoWPAN wireless mesh network, and provide connectivity via wired 10/100 Ethernet to a local area network that may include a LMSM Segment Manager or Building BAS System.

2. Border Router shall provide key information about the health of the mesh network in the form of signal quality, device status, network status, and other real-time network information such as energy monitoring.
3. The LMBR-600 shall have dual internal omni-directional antennas with diversity to ensure reliable communication with Wireless Network Bridges, and provide a user interface for set up and configuration.
4. Include an internal MicroSD card and a Real-time clock with supercap back-up. Border Router shall get power for operation via a 120V outlet (in non-plenum applications) and a dedicated DLM LMPB-100 Power Booster connected to a Cat 5e to DC barrel connector (for plenum applications).

D. Communication between the Wireless Network Bridges and the Border Router

1. The communication between the Wireless Bridges and the Border Router shall be via a standalone wireless mesh network that does not require interface with any other wireless network in the space. The mesh network shall allow communication between all rooms as long as they are within 100' of another connected room.
2. The Wireless Bridges shall communicate over a 6LoWPAN 2.4 GHz IEEE 802.15.4 network and use AES 128 bit Key Encryption for network security.
3. In addition to IEEE IPV6, the Border Router shall have available Constrained Application Protocol (CoAP), Routing Protocol for Low Power Networks (RPL), and Stateless Multicast RPL Forwarding (SMRF).
4. The wireless protocol shall allow BACnet communication to be transported transparently between the Network Bridge and any front end BAS devices such as the LMSM Segment Manager.

E. WattStopper product numbers: Wireless Network Bridge LMBC-600, Wireless Border Router LMBR-600.

2.13 LMCP LIGHTING CONTROL PANELS AND LMZC ZONE CONTROLLER

A. Hardware: Provide LMCP lighting control panels in the locations and capacities as indicated on the Drawing and schedules. Each panel shall be of modular construction and consist of the following components:

1. Enclosure/Tub shall be NEMA 1, sized to accept an interior with 1 - 8 relays, 1 - 24 relays and 6 four-pole contactors, or 1 - 48 relays and 6 four-pole contactors.
2. Cover shall be configured for surface or flush wall mounting of the panel as indicated on the plans. LMCP panel cover shall have a hinged and lockable door with restricted access to line voltage section of the panel.
3. Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. Interior construction shall provide total isolation of high voltage (Class 1) wiring from low voltage (Class 2) wiring within the assembled panel. Interior assembly shall include intelligence boards, power supply, DIN rails for mounting optional Class 2 control devices, and individually replaceable latching type relays. Panel interiors shall include the following features:
 - a. Removable, plug-in terminal blocks with connections for all low voltage terminations.

- b. Individual terminal block, override pushbutton, and LED status light for each relay.
 - c. Direct wired switch inputs associated with each relay shall support 2-wire momentary switches only.
 - d. Digital inputs (four RJ-45 jacks) shall support 1-, 2-, 3-, 4-, and 8-button digital switches; digital IO modules capable of receiving 0-5V or 0-10V analog photocell inputs; digital IO modules capable of receiving momentary or maintained contact closure inputs or analog sensor inputs; digital daylighting sensors; and digital occupancy sensors. Inputs are divided into two separate digital networks, each capable of supplying 250mA to connected devices.
 - e. True relay state shall be indicated by the on-board LED and shall be available to external control devices and systems via BACnet.
 - f. Automatically sequenced operation of relays to reduce impact on the electrical distribution system when large loads are controlled simultaneously.
 - g. Group and pattern control of relays shall be provided through a simple keypad interface from a handheld IR programmer. Any set of relays can be associated with a group for direct on/off control or pattern (scene) control via a simple programming sequence using the relay override pushbuttons and LED displays for groups 1-8 or a handheld IR programmer for groups 1-99.
 - h. Relay group status for shall be provided through LED indicators for groups 1-8 and via BACnet for groups 1-99. A solid LED indicates that the last group action called for an ON state and relays in the group are on or in a mixed state.
4. Single-pole latching relays with modular plug-in design. Relays shall provide the following ratings and features:
- a. Electrical:
 - 1) 30 amp ballast at 277V
 - 2) 20 amp ballast at 347V
 - 3) 20amp tungsten at 120V
 - 4) 30 amp resistive at 347V
 - 5) 1.5 HP motor at 120V
 - 6) 14,000 amp short circuit current rating (SCCR) at 347V
 - 7) Relays shall be specifically UL 20 listed for control of plug-loads
 - b. Mechanical:
 - 1) Replaceable, 1/2 inch KO mounting with removable Class 2 wire harness.
 - 2) Actuator on relay housing provides manual override and visual status indication, accessible from Class 2 section of panel.
 - 3) Dual line and load terminals each support two #14 - #12 solid or stranded conductors.
 - 4) Tested to 300,000 mechanical on/off cycles.
5. Isolated low voltage contacts provide for true relay status feedback and pilot light indication.

6. Power supply shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements. Power supply to have internal over-current protection with automatic reset and metal oxide varistor protection.
7. Where indicated, lighting control panels designated for control of emergency lighting shall be provided with factory installed provision for automatic by pass of relays controlling emergency circuits upon loss of normal power. Panels shall be properly listed and labeled for use on emergency lighting circuits and shall meet the requirements of UL924 and NFPA 70 - Article 700.
8. Integral system clock shall provide scheduling capabilities for panel-only projects without DLM segment networks or BAS control.
 - a. Each panel shall include digital clock capability able to issue system wide automation commands to up to 11 other panels for a total of 12 tnetworked lighting control panels. Clock shall provide capability for up to 254 independent schedule events per panel for each of the ninety-nine system wide channel groups.
 - b. Clock capability of each panel shall support the time-based energy saving requirements of applicable local energy codes.
 - c. Clock module shall provide astronomic capabilities, time delays, blink warning, daylight savings, and holiday functions and will include a battery back up for clock function and program retention in non-volatile FLASH memory. Clocks that require multiple events to meet local code lighting shut off requirements shall not be allowed.
 - d. Clock capability of each panel shall operate on a basis of ON/OFF or Normal Hours/After Hours messages to automation groups that implement pre-configured control scenarios. Scenarios shall include:
 - 1) Scheduled ON / OFF
 - 2) Manual ON / Scheduled OFF
 - 3) Astro ON / OFF (or Photo ON / OFF)
 - 4) Astro and Schedule ON / OFF (or Photo and Schedule ON / OFF)
 - e. User interface shall be a portable IR handheld remote control capable of programming any panel in the system (LMCT-100)
 - f. Clock capability of each panel shall employ non-volatile memory and shall retain user programming and time for a minimum of 10 years.
 - g. Schedules programmed into the clock of any one panel shall be capable of executing panel local schedule or Dark/Light (photocell or Astro) events for that panel in the event that global network communication is lost. Lighting control panels that are not capable of executing events independently of the global network shall not be acceptable.
9. Lighting control panel can operate as a stand-alone system, or can support schedule, group, and photocell control functions, as configured in a Segment Manager controller, via a segment network connection.
10. Lighting control panel shall support digital communications to facilitate the extension of control to include interoperation with building automation systems and other intelligent field devices. Digital communications shall be RS485 MS/TP-based using the BACnet protocol.

- a. Panel shall have provision for an individual BACnet device ID and shall support the full 222 range (0 - 4,193,304). The device ID description property shall be writable via the network to allow unique identification of the lighting control panel on the network.
- b. Panel shall support MS/TP MAC addresses in the range of 0 - 127 and baud rates of 9600k, 38400k, 76800k, and 115.2k bits per second.
- c. Lighting control relays shall be controllable as binary output objects in the instance range of 1 - 64. The state of each relay shall be readable and writable by the BAS via the object present value property.
- d. Lighting control relays shall report their true on/off state as binary input objects in the instance range of 1 - 64.
- e. The 99 group Normal Hours/After Hours control objects associated with the panel shall be represented by binary value objects in the instance range of 201 - 299. The occupancy state of each channel group shall be readable and writable by the BAS via the object present value property. Commanding 1 to a channel group will put all relays associated with the channel into the normal hours mode. Commanding 0 or NULL shall put the relays into the after hours mode.
- f. Setup and commissioning of panel shall not require manufacturer-specific software or a computer. All configuration of the lighting control panel shall be performed using standard BACnet objects or via the handheld IR programming remote. Provide BACnet objects for panel setup and control as follows:
 - 1) Binary output objects in the instance range of 1 - 64 (one per relay) for on/off control of relays.
 - 2) Binary value objects in the instance range of 1 - 99 (one per channel) for normal hours/after hours schedule control.
 - 3) Binary input objects in the instance range of 1 - 64 (one per relay) for reading true on/off state of the relays.
 - 4) Analog value objects in the instance range of 101 - 199 (one per channel group) shall assign a blink warn time value to each channel. A value of 5 shall activate the blink warn feature for the channel and set a 5-minute grace-time period. A value of 250 shall activate the sweep feature for the channel and enable the use of sweep type automatic wall switches.
- g. Description property for all objects shall be writable via the network and shall be saved in non-volatile memory within the panel.
- h. BO and BV 1 - 99 objects shall support BACnet priority array with a relinquish default of off and after hours respectively. Prioritized writes to the channel BV objects shall propagate prioritized control to each member relay in a way analogous to the BACnet Channel object described in addendum aa. (<http://www.bacnet.org/Addenda/Add-135-2010aa.pdf>)
- i. Panel-aggregate control of relay Force Off at priority 2 shall be available via a single BV5 object. Force On at priority 1 shall be available via a single BV4 object.
- j. Lockout of all digital switch buttons connected to a given panel shall be command-able via a single BV2 object. The lock status of any connected switch station shall be represented as BV101-196.

11. In addition to the LMCP Relay Panels, an LMZC Zone Controller panel shall be available for zero-relay applications. The panel is designed for applications where LMFC-011 Fixture Controllers or other distributed load controllers are used to switch and/or dim the controlled loads. Key similarities to and differences from the LMCP panel design shall include:
 - a. Use the same intelligence board as the LMCP relay panel.
 - b. Shall not include relay driver boards or relays.
 - c. Have a removable interior section to facilitate installation, and a Tub/Cover. Cover is for surface mounting applications only.
 - d. Tub shall have two interior KOs to allow installation of LMPB-100 Power Boosters. Each installed Power Booster can provide an additional 150 mA for either of the two available DLM local networks provided by the LMZC.
 - e. All programming and networking (whether DLM Local Network and/or Segment Network) capabilities in the LMZC Zone Controller shall be similar to capabilities for LMCP relay panels, except for functions designed for panel-mounted HDR relays.
 12. To aid in project start up, if LMFC Fixture Controllers are connected to an LMZC Zone Controller, Plug n' Go automatic configuration will establish a unique sequence of operation so that all LMFC-controlled fixtures will turn on to 50 percent output when any digital occupancy sensor detects motion.
 13. WattStopper Product Number: Relay Panels: LMCP8, LMCP24 or LMCP48, Zone Controller: LMZC-301.
- B. User Interface: Each lighting control panel system shall be supplied with at least one handheld configuration tool (LMCT-100). As a remote programming interface the configuration tool shall allow setup, configuration, and diagnostics of the panel without the need for software or connection of a computer. User interface shall have the following panel-specific functions as a minimum:
1. Set network parameters including panel device ID, MS/TP MAC address, baud rate and max master range.
 2. Relay Group creation of up to 99 groups. Group creation shall result in programming of all seven key relay parameters for member relays. The seven parameters are as follows: After-hours Override Time Delay, Normal Hours Override Time Delay, Action on Transition to Normal Hours, Action on Transition to After Hours, Sensor Action During Normal Hours, Sensor Action During After Hours, Blink-Warn Time for After Hours.
 3. Program up to 254 separate scheduled events. Events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays. Holidays are also defined through the User Interface.
 4. Program up to 32 separate Dark/Light events. Events shall have a selectable source as either calculated Astro with delay, or a digital IO module with an integral 0-5V or 0-10V analog photocell. Dark/Light events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays.
 5. Button binding of digital switches to groups shall be accessible via the handheld IR remote and accomplished from the digital switch station.

6. Programming of panel location information shall be accomplished by the handheld IR remote and include at a minimum LAT, LON, DST zone, and an approximate city/state location.
7. WattStopper Product Number: LMCT-100

2.14 SEGMENT MANAGER

- A. For networked applications, the Digital Lighting Management system shall include at least one segment manager to manage network communication. It shall be capable of serving up a graphical user interface via a standard web browser utilizing either unencrypted TCP/IP traffic via a configurable port (default is 80) or 256 bit AES encrypted SSL TCP/IP traffic via a configurable port (default is 443).
- B. Each segment manager shall have integral support for at least three segment networks. Segment networks may alternately be connected to the segment manger via external BACnet-to-IP interface routers and switches, using standard Ethernet structured wiring. Each router shall accommodate one segment network. Provide the quantity of routers and switches as shown on the Drawings.
- C. Operational features of the Segment Manager shall include the following:
 1. Connection to PC or LAN via standard Ethernet TCP/IP via standard Ethernet TCP/IP with the option to use SSL encrypted connections for all traffic.
 2. Easy to learn and use graphical user interface, compatible with Internet Explorer 8, or equal browser. The Segment Manager shall not require installation of any lighting control software on an end-user PC.
 3. Log in security capable of restricting some users to view-only or other limited operations.
 4. Segment Manager shall provide two main sets of interface screens - those used to initially configure the unit (referred to as the config screens), and a those used to allow users to dynamic monitor the performance of their system, and provide a centralized scheduling interface. Capabilities using the Config Screens shall include:
 - a. Automatic discovery of DLM devices and relay panels on the segment network(s). Commissioning beyond activation of the discovery function shall not be required to provide communication, monitoring or control of all local networks and lighting control panels.
 - b. Allow information for all discovered DLM devices to be imported into the Segment Manager via a single XML based site file from the WattStopper LMCS Software, significantly reducing the time needed to make a system usable by the end user. Importable information can include text descriptions of every DLM component and individual loads, and automatic creation of room location information and overall structure of DLM network. Info entered into LMCS should not have to be re-entered manually via keystrokes into the Segment Manager
 - c. After discovery, all rooms and panels shall be presented in a standard navigation tree format. Selecting a device from the tree will allow the device settings and operational parameters to be viewed and changed by the user.

- d. Ability to view and modify DLM device operational parameters. It shall be possible to set device parameters independently for normal hours and after hours operation including sensor time delays and sensitivities, and load response to sensor including Manual-On or Auto-On.
 - e. Provide capabilities for integration with a BAS via BACnet protocol. At a minimum, the following points shall be available to the BAS via BACnet IP connection to the segment manager: room occupancy state; room schedule mode; room switch lock control; individual occupancy sensor state; room lighting power; room plug-load power; load ON/OFF state; load dimming level; panel channel schedule state; panel relay state; and Segment Manager Group schedule state control. Any of above items shall be capable of being moved into an "Export Table" that will provide any integrator with only the data they need, and by using the Export Table effectively create a firewall between the integrator's request for info and the overall system performance.
5. Capabilities using the Segment Manager's Dashboard Screens shall include:
- a. A dynamic "tile" based interface that allows easy viewing of each individual room's lighting and plug load power consumption, and lighting and plug load power density (power consumption information requires Enhanced DLM Room and Plug Load Controllers with integral current transducers such as LMRC-21x). Tiles will be automatically organized according to location so a single tile for the building summarizes all information for tiles beneath it on every floor, in every area, in every room. Tiles use three color coded energy target parameters, allowing an owner to quickly identify rooms that are not performing efficiently. Tiles for rooms with occupancy sensors shall include an icon to indicate whether that room is occupied. Tiles shall be clickable, and when clicked the underlying hierarchical level of tiles shall become visible. Tile interface shall be accessible via mouse, or touch screen devices. Tiles shall be created automatically by the segment manager, based on the information found during the device discovery and/or information included in a file imported in from LMCS (such as tagged descriptions for each room) without any custom programming.
 - b. Ability to set up schedules for DLM local networks (rooms) and panels. Schedules shall be capable of controlling individual rooms with either on/off or normal hours/after hours set controlled zones or areas to either a normal hours or after hours mode of operation. Support for annual schedules, holiday schedules and unique date-bound schedules, as well as astro On or astro Off events with offsets. Schedules shall be viable graphically as time bars in a screen set up to automatically show scheduled events by day, week or month.
 - c. For fixtures that are accessible via the Segment Network, and have CCT capability as specified under paragraph Digital Wall Switch and Timer For Correlated Color Temperature, the Segment Manager will provide schedule functionality similar to the CCT Wall Timer, allowing all CCT fixtures across the entire facility to be scheduled together.
 - d. Ability to provide a simple time vs. power graph based on information stored in each Segment Manager's memory (typically two to three days' data).

6. If shown on the Drawings, Segment Managers shall be integrated into a larger control network by the addition of a Network Supervisor package. The Supervisor is a server level computer running a version of the Segment Manager interface software with dedicated communication and networking capability, able to pull information automatically from each individual Segment Manager in the network. By using a Supervisor, information for individual Segment Managers can be accessed and stored on the Supervisor's hard drive, eliminating the risk of data being overwritten after a few days because of Segment Manager memory limits.
7. Segment Manager shall allow access and control of the overall system database via Native Niagara AX FOX connectivity. Systems that must utilize a Tridium Niagara controller in addition to the programming, scheduling and configuration server are not acceptable.

D. Segment Manager v2.2 and later shall support multiple DLM rooms as follows:

1. Support up to 120 network bridges and 750 digital in-room devices (LMSM-3E).
2. Support up to 200 network bridges and 1,100 digital in room devices, connected via network routers and switches (LMSM-6E).

E. WattStopper Product Numbers: LMSM-3E, LMSM-6E, LM-SUPERVISOR, NB-ROUTER, NB-SWITCH, NB-SWITCH-8, NB-SWITCH-16.

2.15 PROGRAMMING, CONFIGURATION AND DOCUMENTATION SOFTWARE

- A. PC-native application for optional programming of detailed technician-level parameter information for all DLM products, including all parameters not accessible via BACnet and the handled IR configuration tool. Software must be capable of accessing room-level parameter information locally within the room when connected via the optional LMCI-100 USB programming adapter, or globally for many segment networks simultaneously utilizing standard BACnet/IP communication.
- B. Additional parameters exposed through this method include but are not limited to:

1. Occupancy sensor detection LED disable for performance and other aesthetic spaces where blinking LEDs present a distraction.
2. Six occupancy sensor action behaviors for each controlled load, separately configurable for normal hours and after hours modes. Modes include: No Action, Follow Off Only, Follow On Only, Follow On and Off, Follow On Only with Override Time Delay, Follow Off Only with Blink Warn Grace Time, Follow On and Off with Blink Warn Grace Time.
3. Separate fade time adjustments per load for both normal and after hours from 0 - 4 hours.
4. Configurable occupancy sensor re-trigger grace period from 0 - 4 minutes separate for both normal hours and after hours.
5. Separate normal hours and after hours per-load button mode with modes including: Do nothing, on only, off only, on and off.
6. Load control polarity reversal so that on events turn loads off and vice versa.
7. Per-load DR (demand response) shed level in units of percent.
8. Load output pulse mode in increments of 1second.

9. Fade trip point for each load for normal hours and after hours that establishes the dimmer command level at which a switched load closes its relay to allow for staggered On of switched loads in response to a dimmer.
- C. Generation of reports at the whole file, partial file, or room level. Reports include but are not limited to:
1. Device list report: All devices in a project listed by type.
 2. Load binding report: All load controller bindings showing interaction with sensors, switches, and daylighting.
 3. BACnet points report: Per room Device ID report of the valid BACnet points for a given site's BOM.
 4. Room summary report: Device manifest for each room, aggregated by common BOM, showing basic sequence of operations.
 5. Device parameter report: Per-room lists of all configured parameters accessible via hand held IR programmer for use with O&M documentation.
 6. Scene report: All project scene pattern values not left at defaults (i.e. 1 = all loads 100 percent, 2 = all loads 75 percent, 3 = all loads 50 percent, 4 = all loads 25 percent, 5-16 = same as scene 1).
 7. Occupancy sensor report: Basic settings including time delay and sensitivities for all occupancy sensors.
- D. Network-wide programming of parameter data in a spreadsheet-like programming environment including but not limited to the following operations:
1. Set, copy/paste an entire project site of sensor time delays.
 2. Set, copy/paste an entire project site of sensor sensitivity settings.
 3. Search based on room name and text labels.
 4. Filter by product type (i.e. LMRC-212) to allow parameter set by product.
 5. Filter by parameter value to search for product with specific configurations.
- E. Network-wide firmware upgrading remotely via the BACnet/IP network.
1. Mass firmware update of entire rooms.
 2. Mass firmware update of specifically selected rooms or areas.
 3. Mass firmware upgrade of specific products
- F. WattStopper Product Number: LMCS-100, LMCI-100

2.16 EMERGENCY LIGHTING CONTROL DEVICES

- A. Emergency Lighting Control Unit - A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:
1. 120/277 volts, 50/60 Hz, 20 amp ballast rating
 2. Push to test button

- 3. Auxiliary contact for remote test or fire alarm system interface
- B. WattStopper Product Numbers: ELCU-100, ELCU-200.

PART 3 EXECUTION

3.1 PREPARATION

- A. Do not begin installation until measurements have been verified and work areas have been properly prepared.
- B. If preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. Verify that required pre-installation meeting specified in Part 1 of this specification has been completed, recorded meeting minutes have been distributed and all outstanding issues noted have been resolved prior to the start of installation.

3.2 INSTALLATION

- A. Install system in accordance with the approved system shop drawings and manufacturer's instructions.
- B. Install all room/area devices using manufacturer's factory-tested Cat 5e cable with pre-terminated RJ-45 connectors.
 - 1. If pre-terminated cable is not used for room/area wiring, each field-terminated cable shall be tested following installation and testing results submitted to the Manufacturer's Representative for approval prior to proceeding with the Work.
 - 2. If fixtures have internal DLM Control Modules, ensure that they are also connected with Cat 5e cable.
 - 3. Install all room to room network devices using manufacturer-supplied LM-MSTP network wire or wireless devices. Network wire substitution is not permitted and may result in loss of product warranty.
 - 4. Low voltage wiring topology must comply with manufacturer's specifications.
 - 5. Route network wiring as indicated on the Drawings as closely as possible. Document final wiring location, routing and topology on as built drawings.
- C. All line voltage connections shall be tagged to indicate circuit and switched legs.
- D. Test all devices to ensure proper communication.
- E. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings. Adjust time delay so that controlled area remains lighted while occupied.

- F. Provide written or computer-generated documentation on the configuration of the system including room by room description including:
 - 1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
 - 2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
 - 3. Load Parameters (e.g. blink warning, etc.)
- G. Post start-up tuning - Adjust sensor time delays and sensitivities to meet the Owner's requirements 30 days from beneficial occupancy. Provide a detailed report to the Architect / Owner of post start-up activity.
- H. Tighten all panel Class I conductors from both circuit breaker and to loads to torque ratings as marked on enclosure UL label.
- I. All Class II cabling shall enter enclosures from within low-voltage wiring areas and shall remain within those areas. No Class I conductors shall enter a low-voltage area.
- J. Run separate neutrals for any phase dimmed branch load circuit. Different types of dimming loads shall have separate neutral.
- K. Verify all non-panel-based lighting loads to be free from short circuits prior to connection to room controllers.
- L. Remote Access for Network Systems: Ensure Segment Manager enclosure is installed in a location with good to excellent cellular phone coverage based on building orientation and geographic location, and mount magnetic antenna for the modem. For cases where alternate mounting locations are not available and a stronger cellular signal is needed, the manufacturer shall offer additional antenna options to improve signal quality. Verify final mounting location with Engineer and Owner prior to proceeding with the Work.
- M. Provide integration to Building Management System.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Notify Architect and Manufacturer in writing a minimum of 3 weeks prior to system start-up and testing.
- B. Tests and Inspections: Manufacturer's service representative shall perform the following inspections and prepare reports.
 - 1. Verify Class I and II wiring connections are terminated properly by validating system performance.
 - 2. Set IP addresses and other network settings of system front end hardware per facilities IT instructions.
 - 3. Verify / complete task programming for all switches, dimmers, time clocks, and sensors.
 - 4. Verify that the control of each space complies with the Sequence of Operation.

5. Correct any system issues and retest.

C. Provide a report in table format with drawings, or using a software file that can be opened in the manufacturer's system software including each room or space that has lighting control installed. Indicate the following:

1. Date of test or inspection.
2. Loads per space, or Fixture Address identification.
3. Quantity and Type of each device installed
4. Reports providing each device's settings.

3.4 COMMISSIONING ASSISTANCE

A. Title 24 Acceptance Testing Service; Include additional costs for Lighting Control Manufacturer to provide a technician for one additional day while the CLCATT performs lighting control acceptance testing in accordance with CAL TITLE 24 P6 including submission of required documentation.

3.5 DEMONSTRATION AND TRAINING

A. Before Substantial Completion, arrange and provide a one-day Owner instruction period to designated Owner personnel. Set-up, starting of the lighting control system and Owner instruction includes:

1. Confirmation of entire system operation and communication to each device.
2. Confirmation of operation of individual relays, switches, and sensors.
3. Confirmation of system Programming, photocell settings, override settings, etc.
4. Provide training to cover installation, programming, operation, and troubleshooting of the lighting control system.

3.6 PRODUCT SUPPORT AND SERVICE

A. Factory telephone support shall be available at no cost to the Owner following acceptance. Factory assistance shall consist of assistance in solving application issues pertaining to the control equipment.

END OF SECTION 260924

SECTION 262416 - PANELBOARDS

PART 1 GENERAL

1.1 PROJECT INCLUDES

- A. Power distribution panelboards.
- B. Lighting and appliance panelboards.
- C. Overcurrent protective devices for panelboards.

1.2 RELATED REQUIREMENTS

- A. Section 260526 - Grounding and Bonding for Electrical Systems.
- B. Section 260529 - Hangers and Supports for Electrical Systems.
- C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Federal Specification; Revision D, 2006.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- C. NECA 407 - Standard for Installing and Maintaining Panelboards; National Electrical Contractors Association; 2009.
- D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.
- E. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum); National Electrical Manufacturers Association; 2001 (R2006).
- F. NEMA PB 1 - Panelboards; National Electrical Manufacturers Association; 2011.
- G. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; National Electrical Manufacturers Association; 2007.
- H. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.

- I. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- J. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- K. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- L. UL 67 - Panelboards; Current Edition, Including All Revisions.
- M. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.
- N. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
 - 4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features

and accessories.

1. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.

D. Field Quality Control Test Reports.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

F. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.

G. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 016000 - Product Requirements, for additional provisions.
2. Panelboard Keys: Two of each different key.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

- A. Maintain ambient temperature within the following limits during and after installation of panelboards:
 - 1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Schneider Electric; Square D Products: www.schneider-electric.us
- B. Eaton Corporation; Cutler-Hammer Products:
- C. Bussman
- D. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 ALL PANELBOARDS

- A. Provide products listed and labeled by Underwriters Laboratories Inc. as suitable for the purpose indicated.
- B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature:
 - a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
- C. Short Circuit Current Rating:
 - 1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
 - 2. Listed series ratings are acceptable, except where not permitted by motor contribution according to NFPA 70.
 - 3. Label equipment utilizing series ratings as required by NFPA 70.

- D. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
- E. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
- F. Bussing: Sized in accordance with UL 67 temperature rise requirements.
 - 1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
 - 2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
 - 3. Provide separate isolated/insulated ground bus where indicated or where isolated grounding conductors are provided.
- G. Conductor Terminations: Suitable for use with the conductors to be installed.
- H. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 - 2. Boxes: Galvanized steel unless otherwise indicated.
 - a. Provide wiring gutters sized to accommodate the conductors to be installed.
 - b. Increase gutter space as required where sub-feed lugs, feed-through lugs, gutter taps, or oversized lugs are provided.
 - c. Provide painted steel boxes for surface-mounted panelboards where indicated, finish to match fronts.
 - 3. Fronts:
 - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
 - b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
 - 4. Lockable Doors: All locks keyed alike unless otherwise indicated.
- I. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
- J. Multi-Section Panelboards: Provide enclosures of the same height, with feed-through lugs or sub-feed lugs and feeders as indicated or as required to interconnect sections.
- K. Load centers are not acceptable.
- L. Provide the following features and accessories where indicated or where required to complete installation:

1. Feed-through lugs.
2. Sub-feed lugs.

2.3 POWER DISTRIBUTION PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Conductor Terminations:
1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
 2. Main and Neutral Lug Type: Mechanical.
- C. Bussing:
1. Phase and Neutral Bus Material: Copper.
 2. Ground Bus Material: Copper.
- D. Circuit Breakers:
1. Provide bolt-on type secured with locking mechanical restraints.
 2. Provide thermal magnetic circuit breakers unless otherwise indicated.
 3. Provide electronic trip circuit breakers where indicated.
- E. Enclosures:
1. Provide surface-mounted enclosures unless otherwise indicated.
 2. Fronts: Provide trims to cover access to load terminals, wiring gutters, and other live parts, with exposed access to overcurrent protective device handles.

2.4 LIGHTING AND APPLIANCE PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Conductor Terminations:
1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
 2. Main and Neutral Lug Type: Mechanical.

C. Bussing:

1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
2. Phase and Neutral Bus Material: Copper.
3. Ground Bus Material: Copper.

D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.

E. Enclosures:

1. Provide surface-mounted or flush-mounted enclosures as indicated.
2. Fronts: Provide lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
3. Provide clear plastic circuit directory holder mounted on inside of door.

2.5 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:

1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
2. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - 1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
 - 2) 14,000 rms symmetrical amperes at 480 VAC.
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
 - c. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.
3. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Provide compression lugs where indicated.
 - c. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
5. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
6. Provide the following circuit breaker types where indicated:
7. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving fluorescent lighting.
8. Do not use tandem circuit breakers.

9. Do not use handle ties in lieu of multi-pole circuit breakers.
10. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.
11. Provide the following features and accessories where indicated or where required to complete installation:
 - a. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.

2.6 SOURCE QUALITY CONTROL

- A. Factory test panelboards according to NEMA PB 1.

2.7 COORDINATION PANELBOARDS

- A. Bussman Quick-Spec Panelboards.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive panelboards.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install panelboards securely, in a neat and workmanlike manner in accordance with NECA 1 (general workmanship), NECA 407 (panelboards), and NEMA PB 1.1.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required supports in accordance with Section 260529.
- E. Install panelboards plumb.

- F. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
- G. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
- H. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.
- I. Provide grounding and bonding in accordance with Section 260526.
 - 1. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on isolated/insulated ground bus.
 - 2. Terminate branch circuit isolated grounding conductors on isolated/insulated ground bus only. Do not terminate on solidly bonded equipment ground bus.
- J. Install all field-installed branch devices, components, and accessories.
- K. Multi-Wire Branch Circuits: Group grounded and ungrounded conductors together in the panelboard as required by NFPA 70.
- L. Set field-adjustable circuit breaker tripping function settings as indicated.
- M. Set field-adjustable ground fault protection pickup and time delay settings as indicated.
- N. Provide filler plates to cover unused spaces in panelboards.
- O. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:
- P. Identify panelboards in accordance with Section 260553.
- Q. Provide spare conduits out of each recessed panelboard to an accessible location above ceiling. Identify each as SPARE.

3.3 FIELD QUALITY CONTROL

- A. Perform inspection, testing, and adjusting in accordance with Section 014000.
- B. Perform field inspection and testing in accordance with Section 014000.
- C. Inspect and test in accordance with NETA STD ATS, except Section 4.
- D. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA STD ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than 225

amperes. Tests listed as optional are not required.

- E. Test shunt trips to verify proper operation.
- F. Correct deficiencies and replace damaged or defective panelboards or associated components.
- G. Perform inspections and tests listed in NETA STD ATS, Section 7.5 for switches, Section 7.6 for circuit breakers.

3.4 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of panelboard fronts.

3.5 CLEANING

- A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 262416

SECTION 262717 – EQUIPMENT WIRING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical connections to equipment.

1.2 RELATED REQUIREMENTS

- A. Section 26 0534 - Conduit.
- B. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables (600 V and Less).
- C. Section 26 0537 - Boxes.
- D. Section 26 2818 - Enclosed Switches.

1.3 REFERENCE STANDARDS

- A. NEMA WD 1 - General Color Requirements for Wiring Devices; National Electrical Manufacturers Association; 1999 (R 2005).
- B. NEMA WD 6 - Wiring Devices - Dimensional Requirements; National Electrical Manufacturers Association; 2002 (R2008).
- C. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.

1.5 COORDINATION

- A. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.

- B. Determine connection locations and requirements.
- C. Sequence rough-in of electrical connections to coordinate with installation of equipment.
- D. Sequence electrical connections to coordinate with start-up of equipment.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
 - 1. Colors: Conform to NEMA WD 1.
 - 2. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.
 - 3. Substitutions: See Section 01 6000 - Product Requirements.
- B. Wiring Devices: As specified in Section 26 2726.
- C. Flexible Conduit: As specified in Section 26 0534.
- D. Wire and Cable: As specified in Section 26 0519.
- E. Boxes: As specified in Section 26 0537.

PART 3 EXECUTION

3.1 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Provide receptacle outlet to accommodate connection with attachment plug.
- E. Provide cord and cap where field-supplied attachment plug is required.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

- G. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION 262717

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SECTION 262726 - WIRING DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Wall switches.
- B. Wall dimmers.
- C. Receptacles.
- D. Wall plates.
- E. Floor box service fittings.
- F. Poke-through assemblies.
- G. Access floor boxes.

1.2 RELATED REQUIREMENTS

- A. Section 096900 - Access Flooring.
- B. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Manufactured wiring systems for use with access floor boxes with compatible pre-wired connectors.
- C. Section 260533.16 - Boxes for Electrical Systems.
- D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 271000 - Structured Cabling: Voice and data jacks.

1.3 REFERENCE STANDARDS

- A. FS W-C-596 - Connector, Electrical, Power, General Specification for; 2014h, with Amendments (2017).
- B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush-mounted (General Specification); 2014g, with Amendment (2017).
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- D. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2016.

- E. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (Reaffirmed 2020).
- F. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2021.
- G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. UL 20 - General-Use Snap Switches; Current Edition, Including All Revisions.
- I. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.
- J. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.
- K. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.
- L. UL 1310 - Class 2 Power Units; Current Edition, Including All Revisions.
- M. UL 1472 - Solid-State Dimming Controls; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
 - 3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
 - 4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
 - 5. Coordinate the core drilling of holes for poke-through assemblies with the work covered under other sections.
 - 6. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.
- B. Sequencing:
 - 1. Do not install wiring devices until final surface finishes and painting are complete.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
 - 1. Wall Dimmers: Include derating information for ganged multiple devices.

- C. Field Quality Control Test Reports.
- D. Operation and Maintenance Data:
 - 1. Wall Dimmers: Include information on operation and setting of presets.
 - 2. GFCI Receptacles: Include information on status indicators.
- E. Project Record Documents: Record actual installed locations of wiring devices.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Screwdrivers for Tamper-Resistant Screws: Two for each type of screw.
 - 3. Extra Keys for Locking Switches: Two of each type.
 - 4. Extra Wall Plates: One of each style, size, and finish.
 - 5. Extra Flush Floor Service Fittings: Two of each type.
 - 6. Extra Poke-Through Core Hole Closure Plugs: Two for each core size.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Products: Listed, classified, and labeled as suitable for the purpose intended.
- E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.1 WIRING DEVICE APPLICATIONS

- A. Provide wiring devices suitable for intended use and with ratings adequate for load served.

- B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.
- C. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.
- D. Provide GFCI protection for receptacles installed within 6 feet of sinks.
- E. Provide GFCI protection for receptacles installed in kitchens.
- F. Provide GFCI protection for receptacles serving electric drinking fountains.
- G. Unless noted otherwise, do not use combination switch/receptacle devices.
- H. For flush floor service fittings, use tile rings for installations in tile floors.
- I. For flush floor service fittings, use carpet flanges for installations in carpeted floors.

2.2 WIRING DEVICE FINISHES

- A. Provide wiring device finishes as selected by Architect..

2.3 WALL SWITCHES

- A. Manufacturers:
 - 1. Hubbell Incorporated; _____: www.hubbell.com/#sle.
 - 2. Leviton Manufacturing Company, Inc; _____: www.leviton.com/#sle.
 - 3. Pass & Seymour, a brand of Legrand North America, Inc; _____: www.legrand.us/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
- C. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
- D. Lighted Wall Switches: Industrial specification grade, 20 A, 120/277 V with illuminated standard toggle type switch actuator and maintained contacts; illuminated with load off; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

- E. Pilot Light Wall Switches: Industrial specification grade, 20 A, 120/277 V with red illuminated standard toggle type switch actuator and maintained contacts; illuminated with load on; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
- F. Locking Wall Switches: Industrial specification grade, 20 A, 120/277 V with lever type keyed switch actuator and maintained contacts; switches keyed alike; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
- G. Momentary Contact Wall Switches: Industrial specification grade, 20 A, 120/277 V with toggle type three position switch actuator and momentary contacts; single pole double throw, off with switch actuator in center position.
- H. Locking Momentary Contact Wall Switches: Industrial specification grade, 20 A, 120/277 V with lever type keyed three position switch actuator and momentary contacts; switches keyed alike; single pole double throw, off with switch actuator in center position.

2.4 WALL DIMMERS

- A. Manufacturers:
 - 1. Leviton Manufacturing Company, Inc; _____: www.leviton.com/#sle.
 - 2. Lutron Electronics Company, Inc; Maestro Series: www.lutron.com/#sle.
 - 3. Pass & Seymour, a brand of Legrand North America, Inc; _____: www.legrand.us/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Wall Dimmers - General Requirements: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.
- C. Control: Slide control type with separate on/off switch.
- D. Power Rating, Unless Otherwise Indicated or Required to Control the Load Indicated on the Drawings:

2.5 RECEPTACLES

- A. Manufacturers:
 - 1. Hubbell Incorporated; _____: www.hubbell.com/#sle.
 - 2. Lutron Electronics Company, Inc; Designer Style: www.lutron.com/#sle.
 - 3. Pass & Seymour, a brand of Legrand North America, Inc; _____: www.legrand.us/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.

5. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.
- B. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
 2. NEMA configurations specified are according to NEMA WD 6.
- C. Convenience Receptacles:
1. Standard Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
 2. Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SD suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
 3. Tamper Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; single or duplex as indicated on the drawings.
 4. Tamper Resistant and Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SD suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
- D. GFCI Receptacles:
1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
 - a. Provide test and reset buttons of same color as device.
 2. Standard GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
 3. Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SD suitable for installation in damp or wet locations.
 4. Tamper Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type.
 5. Tamper Resistant and Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SD suitable for installation in damp or wet locations.
- E. USB Charging Devices:
1. USB Charging Devices - General Requirements: Listed as complying with UL 1310.

- a. Charging Capacity - Two-Port Devices: 2.1 A, minimum.
 - 2. USB Charging/Tamper Resistant Receptacle Combination Devices: One-port (Type A) and One-Port (Type C) USB charging device and receptacle, commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; rectangular decorator style.
- F. Locking Receptacles: Industrial specification grade, configuration as indicated on the drawings.
- 1. Standard Locking Convenience Receptacles: Single, 20A, 125V, NEMA L5-20R.

2.6 WALL PLATES

- A. Manufacturers:
- 1. Hubbell Incorporated; _____: www.hubbell-wiring.com/#sle.
 - 2. Leviton Manufacturing Company, Inc; _____: www.leviton.com/#sle.
 - 3. Lutron Electronics Company, Inc; _____: www.lutron.com/#sle.
 - 4. Pass & Seymour, a brand of Legrand North America, Inc; _____: www.legrand.us/#sle.
 - 5. Substitutions: See Section 016000 - Product Requirements.
 - 6. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.
- B. Wall Plates: Comply with UL 514D.
- 1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
 - 2. Size: Standard; _____.
 - 3. Screws: Metal with slotted heads finished to match wall plate finish.
- C. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.
- D. Premarked Wall Plates: Factory labeled as indicated; hot stamped for nylon wall plates and engraved for metal wall plates.
- E. Weatherproof Covers for Damp Locations: Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.
- F. Weatherproof Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

2.7 FLOOR BOX SERVICE FITTINGS

- A. Manufacturers:
- 1. Hubbell Incorporated; _____: www.hubbell.com/#sle.

2. Thomas & Betts Corporation; _____: www.tnb.com/#sle.
 3. Wiremold, a brand of Legrand North America, Inc; _____: www.legrand.us/#sle.
 4. Substitutions: See Section 016000 - Product Requirements.
- B. Description: Service fittings compatible with floor boxes provided under Section 260533.16 with components, adapters, and trims required for complete installation.
- C. Above-Floor Service Fittings:
1. Single Service Pedestal Convenience Receptacles:
 - a. Configuration: One standard convenience duplex receptacle.
 2. Single Service Pedestal Communications Outlets:
 - a. Configuration: One 1 inch bushed opening.
 - b. Voice and Data Jacks: As specified in Section 271000.
 3. Single Service Pedestal Furniture Feed:
 - a. Configuration: One 3/4 inch knockout.
 4. Dual Service Pedestal Combination Outlets:
 - a. Configuration:
 - 1) Power: One standard convenience duplex receptacle.
 - 2) Communications: One 1 inch bushed opening.
 - 3) Voice and Data Jacks: As specified in Section 271000.
 - b. Provide barrier to separate line and low voltage compartments.
- D. Flush Floor Service Fittings:
1. Single Service Flush Convenience Receptacles:
 - a. Cover: Rectangular.
 - b. Configuration: One standard convenience duplex receptacle(s) with duplex flap opening(s).
 2. Single Service Flush Communications Outlets:
 - a. Cover: Rectangular.
 - b. Configuration: _____.
 - c. Voice and Data Jacks: As specified in Section 271000.
 3. Accessories:
 - a. Tile Rings: Finish to match covers; configuration as required to accommodate specified covers.
 - b. Carpet Flanges: Finish to match covers; configuration as required to accommodate specified covers.

2.8 POKE-THROUGH ASSEMBLIES

- A. Manufacturers:
1. Hubbell Incorporated; _____: www.hubbell.com/#sle.
 2. Thomas & Betts Corporation; _____: www.tnb.com/#sle.
 3. Wiremold, a brand of Legrand North America, Inc; _____: www.legrand.us/#sle.
 4. Substitutions: See Section 016000 - Product Requirements.

- B. Description: Assembly comprising floor service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination; fire rating listed to match fire rating of floor and suitable for floor thickness where installed.
- C. Above-Floor Service Fittings:
 - 1. Single Service Pedestal Convenience Receptacles:
 - a. Configuration: One standard convenience duplex receptacle.
 - 2. Single Service Pedestal Communications Outlets:
 - a. Configuration: One 1 inch bushed opening.
 - b. Voice and Data Jacks: As specified in Section 271000.
- D. Flush Floor Service Fittings:
 - 1. Accessories:
 - a. Closure Plugs: Size and fire rating as required to seal unused core hole and maintain fire rating of floor.

2.9 ACCESS FLOOR BOXES

- A. Manufacturers - Access Floor Boxes:
 - 1. Hubbell Incorporated; _____: www.hubbell-wiring.com/#sle.
 - 2. Thomas & Betts Corporation; _____: www.tnb.com/#sle.
 - 3. Wiremold, a brand of Legrand North America, Inc; _____: www.legrand.us/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Manufacturers - Access Floor Boxes with Pre-wired Connectors for Manufactured Wiring Systems:
 - 1. AFC Cable Systems Inc; _____: www.afcweb.com/#sle.
 - 2. RELOC Wiring Solutions, a brand of Acuity Brands, Inc; _____: www.relocwiring.com/#sle.
 - 3. Wiremold, a brand of Legrand North America, Inc; _____: www.legrand.us/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.
 - 5. Source Limitations: Provide access floor boxes with pre-wired connectors produced by the same manufacturer as the manufactured wiring system used for this project.
- C. Description: Metallic multi-service box suitable for mounting in access floor system specified in Section 096900.
- D. Access floor boxes with pre-wired connectors for manufactured wiring systems are permitted only where manufactured wiring systems are permitted as specified in Section 260519.
- E. Configuration:
 - 1. Power: Two standard convenience duplex receptacle(s).
 - 2. Voice and Data Jacks: As specified in Section 271000.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that floor boxes are adjusted properly.
- F. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- G. Verify that core drilled holes for poke-through assemblies are in proper locations.
- H. Verify that openings in access floor are in proper locations.
- I. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 260533.16 as required for installation of wiring devices provided under this section.
 - 1. Mounting Heights: Unless otherwise indicated, as follows:
 - a. Wall Switches: 48 inches above finished floor.
 - b. Wall Dimmers: 48 inches above finished floor.
 - c. Receptacles: 18 inches above finished floor or 6 inches above counter.
 - 2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.

3. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
 4. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
 5. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.
- C. Install wiring devices in accordance with manufacturer's instructions.
- D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- E. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
- F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- H. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.
- I. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- J. Install wall switches with OFF position down.
- K. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
- L. Do not share neutral conductor on branch circuits utilizing wall dimmers.
- M. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
- N. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- O. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.

- P. Identify wiring devices in accordance with Section 260553.
- Q. Install poke-through closure plugs in each unused core holes to maintain fire rating of floor.

3.4 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect each wiring device for damage and defects.
- C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.
- D. Test each receptacle to verify operation and proper polarity.
- E. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- F. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.5 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.
- B. Adjust presets for wall dimmers according to manufacturer's instructions as directed by Architect.

3.6 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION 262726

SECTION 264300 - SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Surge protective devices for service entrance locations.
- B. Surge protective devices for distribution locations.
- C. Surge protective devices for branch panelboard locations.

1.2 RELATED REQUIREMENTS

- A. Section 260526 - Grounding and Bonding for Electrical Systems.
- B. Section 262300 - Low-Voltage Switchgear.
- C. Section 262413 - Switchboards.
- D. Section 262416 - Panelboards.
- E. Section 271000 - Structured Cabling: Protectors for communications service entrance.

1.3 ABBREVIATIONS AND ACRONYMS

- A. EMI/RFI: Electromagnetic Interference/Radio Frequency Interference.
- B. SPD: Surge Protective Device.

1.4 REFERENCE STANDARDS

- A. MIL-STD-220 - Method of Insertion Loss Measurement; 2009c (Validated 2014).
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2018.
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 1283 - Standard for Electromagnetic Interference Filters; Current Edition, Including All Revisions.

- G. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate size and location of overcurrent device compatible with the actual surge protective device and location to be installed. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to ordering equipment.

1.6 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Include detailed component information, voltage, surge current ratings, repetitive surge current capacity, voltage protection rating (VPR) for all protection modes, maximum continuous operating voltage (MCOV), nominal discharge current (I-n), short circuit current rating (SCCR), connection means including any required external overcurrent protection, enclosure ratings, outline and support point dimensions, weight, service condition requirements, and installed features.
 - 1. SPDs with EMI/RFI filter: Include noise attenuation performance.
- C. Shop Drawings: Include wiring diagrams showing all factory and field connections with wire and circuit breaker/fuse sizes.
- D. Certificates: Manufacturer's documentation of listing for compliance with the following standards:
 - 1. UL 1449.
 - 2. UL 1283 (for Type 2 SPDs).
- E. Field Quality Control Test Reports.
- F. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- G. Operation and Maintenance Data: Include information on status indicators and recommended maintenance procedures and intervals.
- H. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- I. Project Record Documents: Record actual connections and locations of surge protective devices.

1.7 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.8 DELIVERY, STORAGE, AND PROTECTION

- A. Store in a clean, dry space in accordance with manufacturer's written instructions.

1.9 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.10 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Manufacturer's Warranty: Provide minimum ten year warranty covering repair or replacement of surge protective devices showing evidence of failure due to defective materials or workmanship.
- C. Exclude surge protective devices from any clause limiting warranty responsibility for acts of nature, including lightning, stated elsewhere.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Schneider Electric
- B. Field-installed, Externally Mounted Surge Protective Devices - Other Acceptable Manufacturers:
 - 1. Advanced Protection Technologies (APT)
 - 2. ASCO Power Technologies
- C. Factory-installed, Internally Mounted Surge Protective Devices:
 - 1. Same as manufacturer of equipment containing surge protective device, to provide a complete listed assembly including SPD.
- D. Substitutions: See Section 016000 - Product Requirements.

2.2 SURGE PROTECTIVE DEVICES - GENERAL REQUIREMENTS

- A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service; listed, classified, and labeled as suitable for the purpose intended; system voltage as indicated on the drawings.
- B. Unless otherwise indicated, provide field-installed, externally-mounted or factory-installed, internally-mounted SPDs.
- C. List and label as complying with UL 1449, Type 1 when connected on line side of service disconnect overcurrent device and Type 1 or 2 when connected on load side of service disconnect overcurrent device.
- D. Protected Modes:
 - 1. Wye Systems: L-N, L-G, N-G, L-L.
- E. UL 1449 Voltage Protection Ratings (VPRs):
 - 1. 208Y/120V System Voltage: Not more than 800V for L-N, L-G, and N-G modes and 1,200 V for L-L mode.
 - 2. 480Y/277V System Voltage: Not more than 1,200 V for L-N, L-G, and N-G modes and 2,000 V for L-L mode.
- F. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.
- G. Enclosure Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - 1. Indoor clean, dry locations: NEMA Type 1.
 - 2. Outdoor locations: NEMA Type 3R.
- H. Mounting for Field-installed, Externally Mounted SPDs: Unless otherwise indicated, as specified for the following locations:
 - 1. Provide surface-mounted SPD where mounted in non-public areas or adjacent to surface-mounted equipment.
 - 2. Provide flush-mounted SPD where mounted in public areas or adjacent to flush-mounted equipment.
- I. Equipment Containing Factory-installed, Internally Mounted SPDs: Listed and labeled as a complete assembly including SPD.
 - 1. Switchgear: See Section 262300.
 - 2. Switchboards: See Section 262413.

2.3 SURGE PROTECTIVE DEVICES FOR SERVICE ENTRANCE LOCATIONS

A. Surge Protective Device:

1. Protection Circuits: Field-replaceable modular or non-modular.
2. Surge Current Rating: Not less than 120 kA per mode/240 kA per phase.
(EMA Series) Model: SSPxxEMA24
3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
5. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).
6. Diagnostics:
 - a. Protection Status Monitoring: Provide indicator lights to report the protection for each phase.
 - b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
 - c. Remote Status Monitoring: Provide Form C dry type contacts (normally open and normally closed) for remote annunciation of status.
 - d. Surge Counter: Provide surge event counter with manual reset button, surge count retention upon power loss, and six digit LCD display that indicates quantity of surge events.
7. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

2.4 SURGE PROTECTIVE DEVICES FOR DISTRIBUTION LOCATIONS

A. Distribution locations include SPDs connected to distribution panelboards, motor control centers, and busway.

B. Surge Protective Device:

1. Protection Circuits: Field-replaceable modular or non-modular.
2. Surge Current Rating: Not less than 80 kA per mode/160 kA per phase.
(EMA Series) Model: SSPxxEMA16
3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
5. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).
 - a. Noise Attenuation: Not less than -50 dB at 100 kHz using MIL-STD-220 insertion loss test method.
6. Diagnostics:

- a. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.
 - b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
 - c. Remote Status Monitoring: Provide Form C dry type contacts (normally open and normally closed) for remote annunciation of status.
 - d. Surge Counter: Provide surge event counter with manual reset button, surge count retention upon power loss, and six digit LCD display that indicates quantity of surge events.
7. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

2.5 SURGE PROTECTIVE DEVICES FOR BRANCH PANELBOARD LOCATIONS

A. Surge Protective Device:

1. Protection Circuits: Field-replaceable modular or non-modular.
2. Surge Current Rating: Not less than 50 kA per mode/100 kA per phase.
(XDSE Series) Model: SSPxxXDSE10A
3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
5. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).
 - a. Noise Attenuation: Not less than 40 dB at 100 kHz using MIL-STD-220 insertion loss test method.
6. Diagnostics:
 - a. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.
 - b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
 - c. Remote Status Monitoring: Provide Form C dry type contacts (normally open and normally closed) for remote annunciation of status.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the service voltage and configuration marked on the SPD are consistent with the service voltage and configuration at the location to be installed.

- C. Verify that electrical equipment is ready to accept connection of the SPD and that installed overcurrent device is consistent with requirements of drawings and manufacturer's instructions.
- D. Verify system grounding and bonding is in accordance with Section 260526, including bonding of neutral and ground for service entrance and separately derived systems where applicable. Do not energize SPD until deficiencies have been corrected.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- C. Unless indicated otherwise, connect service entrance surge protective device on load side of service disconnect main overcurrent device.
- D. Provide conductors with minimum ampacity as indicated on the drawings, as required by NFPA 70, and not less than manufacturer's recommended minimum conductor size.
- E. Install conductors between SPD and equipment terminations as short and straight as possible, not exceeding manufacturer's recommended maximum conductor length. Breaker locations may be reasonably rearranged in order to provide leads as short and straight as possible. Twist conductors together to reduce inductance.
- F. Do not energize SPD until bonding of neutral and ground for service entrance and separately derived systems is complete in accordance with Section 260526 where applicable. Replace SPDs damaged by improper or missing neutral-ground bond.
- G. Disconnect SPD prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPD connected.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS Section 7.19.1.
- D. Procure services of a qualified manufacturer's representative to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's reports with field quality control submittals.

3.4 CLEANING

- A. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 264300

SECTION 265100 - INTERIOR LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Interior luminaires.
- B. Exit signs.
- C. Ballasts and drivers.
- D. Accessories.

1.2 RELATED REQUIREMENTS

- A. Section 260529 - Hangers and Supports for Electrical Systems.
- B. Section 260533.16 - Boxes for Electrical Systems.
- C. Section 260548 - Vibration and Seismic Controls for Electrical Systems.
- D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 260923 - Lighting Control Devices.
- F. Section 262726 - Wiring Devices: Manual wall switches and wall dimmers.

1.3 REFERENCE STANDARDS

- A. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code); 2013 (Corrigendum 2019).
- B. IES LM-63 - Approved Method: IES Standard File Format for the Electronic Transfer of Photometric Data and Related Information; 2019.
- C. IES LM-79 - Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products; 2019.
- D. IES LM-80 - Approved Method: Measuring Maintenance of Light Output Characteristics of Solid-State Light Sources ; 2021.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

- F. NECA/IESNA 500 - Standard for Installing Indoor Lighting Systems; 2006.
- G. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems; 1999 (Reaffirmed 2006).
- H. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts; 2020.
- I. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; 2012 (Reaffirmed 2018).
- J. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- K. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- L. UL 844 - Luminaires for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.
- M. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.
- N. UL 1598 - Luminaires; Current Edition, Including All Revisions.
- O. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
 - 2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
 - 3. Coordinate the placement of exit signs with furniture, equipment, signage or other potential obstructions to visibility installed under other sections or by others.
 - 4. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.

- B. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
 - 1. LED Luminaires:
 - a. Include estimated useful life, calculated based on IES LM-80 test data.
 - b. Include IES LM-79 test report upon request.
 - 2. Provide electronic files of photometric data certified by a National Voluntary Laboratory Accreditation Program (NVLAP) lab or independent testing agency in IES LM-63 standard format upon request.
- C. Samples:
 - 1. Provide one sample(s) of each specified luminaire upon request.
- D. Field quality control reports.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- F. Operation and Maintenance Data: Instructions for each product including information on replacement parts.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Lenses and Louvers: Two percent of total quantity installed for each type, but not less than one of each type.
 - 3. Extra Drivers: Two percent of total quantity installed for each type, but not less than one of each type.
- H. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.8 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.9 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Provide 5-year manufacturer warranty for LED luminaires, including drivers.

PART 2 PRODUCTS

2.1 LUMINAIRE TYPES

- A. Furnish products as indicated in luminaire schedule included on the drawings.
- B. Substitutions: See Section 016000 - Product Requirements.

2.2 LUMINAIRES

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.

- F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- G. Recessed Luminaires:
 - 1. Ceiling Compatibility: Comply with NEMA LE 4.
 - 2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
 - 3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.
- H. Hazardous (Classified) Location Luminaires: Listed and labeled as complying with UL 844 for the classification of the installed location.
- I. LED Luminaires:
 - 1. Components: UL 8750 recognized or listed as applicable.
 - 2. Tested in accordance with IES LM-79 and IES LM-80.
 - 3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.
- J. LED Tape Lighting Systems: Provide all power supplies, drivers, cables, connectors, channels, covers, mounting accessories, and interfaces as necessary to complete installation.
 - 1. LED Tape - General Requirements:
 - a. Listed.
 - b. Designed for field cutting in accordance with listing.
 - c. Wet Location Applications: IEC 60529, IP 68 (waterproof) rated.
- K. Track Lighting Systems: Provide track compatible with specified track heads, with all connectors, power feed fittings, dead ends, hangers and canopies as necessary to complete installation.
- L. Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with all accessories required for joining and aligning.

2.3 EXIT SIGNS

- A. Description: Exit signs complying with NFPA 101 and applicable state and local codes, and listed and labeled as complying with UL 924.
 - 1. Number of Faces: Single- or double-face as indicated or as required for installed location.
 - 2. Directional Arrows: As indicated or as required for installed location.
- B. Powered Exit Signs: Internally illuminated with LEDs unless otherwise indicated.

2.4 BALLASTS AND DRIVERS

- A. Ballasts/Drivers - General Requirements:

1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
 2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.
 3. Electronic Ballasts/Drivers: Inrush currents not exceeding peak currents specified in NEMA 410.
- B. Dimmable LED Drivers:
1. Dimming Range: Continuous dimming from 100 percent to one percent relative light output unless dimming capability to lower level is indicated, without flicker.
 2. Control Compatibility: Fully compatible with the dimming controls to be installed.
 - a. Wall Dimmers: See Section 262726.
 - b. Daylighting Controls: See Section 260923.

2.5 ACCESSORIES

- A. Stems for Suspended Luminaires: Steel tubing, minimum 1/2" size, factory finished to match luminaire or field-painted as directed.
- B. Threaded Rods for Suspended Luminaires: Zinc-plated steel, minimum 1/4" size, field-painted as directed.
- C. Provide accessory plaster frames for luminaires recessed in plaster ceilings.
- D. Fire-Rated Luminaire Enclosures:
1. Manufacturers:
 - a. Fire Rated Product Specialties Corp; _____: www.frpsonline.com/#sle.
 - b. Specialty Products & Insulation (SPI); SafeLite: www.spi-co.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.
 2. Provide as required to preserve fire resistance rating of building elements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
- C. Verify that suitable support frames are installed where required.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 260533.16 as required for installation of luminaires provided under this section.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install products in accordance with manufacturer's instructions.
- D. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting) and NECA 502 (industrial lighting).
- E. Provide required support and attachment in accordance with Section 260529.
- F. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- G. Suspended Ceiling Mounted Luminaires:
 - 1. Do not use ceiling tiles to bear weight of luminaires.
 - 2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
 - 3. Secure surface-mounted and recessed luminaires to building structure.
 - 4. Secure pendant-mounted luminaires to building structure.
 - 5. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
 - 6. In addition to ceiling support wires, provide two galvanized steel safety wire(s), minimum 12 gauge, connected from opposing corners of each recessed luminaire to building structure.
 - 7. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.
- H. Recessed Luminaires:
 - 1. Install trims tight to mounting surface with no visible light leakage.
 - 2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.
 - 3. Luminaires Recessed in Fire-Rated Ceilings: Install using accessories and firestopping materials to meet regulatory requirements for fire rating.
- I. Suspended Luminaires:
 - 1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.

2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
 3. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet nominal length, with no more than 4 feet between supports.
 4. Install canopies tight to mounting surface.
 5. Unless otherwise indicated, support pendants from swivel hangers.
- J. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.
- K. Install accessories furnished with each luminaire.
- L. Bond products and metal accessories to branch circuit equipment grounding conductor.
- M. Exit Signs:
1. Unless otherwise indicated, connect unit to unswitched power. Bypass local switches, contactors, or other lighting controls.
 2. Install lock-on device on branch circuit breaker serving units.
- N. Remote Drivers: Install in accessible location as indicated or as required to complete installation, using conductors per manufacturer's recommendations not exceeding manufacturer's recommended maximum conductor length to luminaire.
- O. Install lamps in each luminaire.

3.4 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect each product for damage and defects.
- C. Operate each luminaire after installation and connection to verify proper operation.
- D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.5 ADJUSTING

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.
- B. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Architect or authority having jurisdiction.

3.6 CLEANING

- A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals, for closeout submittals.
- B. See Section 017900 - Demonstration and Training, for additional requirements.
- C. Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.
- D. Just prior to Substantial Completion, replace all lamps that have failed.

3.8 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

END OF SECTION 265100

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SECTION 265600 - EXTERIOR LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Exterior luminaires.
- B. Poles and accessories.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Materials and installation requirements for concrete bases for poles.
- B. Section 260526 - Grounding and Bonding for Electrical Systems.
- C. Section 260533.16 - Boxes for Electrical Systems.

1.3 REFERENCE STANDARDS

- A. 47 CFR 15 - Radio Frequency Devices; current edition.
- B. IEEE C2 - National Electrical Safety Code; 2017.
- C. IEEE C62.41.2 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (Corrigendum 2012).
- D. IESNA LM-63 - ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information; 2002 (Reaffirmed 2008).
- E. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; 2008.
- F. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules; 2015, with Errata (2017).
- G. IES RP-8 - Recommended Practice for Roadway Lighting; 2014.
- H. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- I. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems; 2006.

- J. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts; 2016.
- K. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; 2012.
- L. NFPA 70 - National Electrical Code; 2017.
- M. UL 844 - Luminaires for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.
- N. UL 1598 - Luminaires; Current Edition, Including All Revisions.
- O. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate placement of poles and associated foundations with utilities, curbs, sidewalks, trees, walls, fences, striping, etc. installed under other sections or by others. Coordinate elevation to obtain specified foundation height.
 - 2. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings:
 - 1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
 - 2. Provide photometric calculations where luminaires are proposed for substitution upon request.
 - 3. Provide structural calculations for each pole proposed for substitution.
- C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, weight, effective projected area (EPA), and installed accessories; include model number nomenclature clearly marked with all proposed features.
 - 1. LED Luminaires:
 - a. Include estimated useful life, calculated based on IES LM-80 test data.

- b. Include IES LM-79 test report upon request.
2. Provide electronic files of photometric data certified by a National Voluntary Laboratory Accreditation Program (NVLAP) lab or independent testing agency in IESNA LM-63 standard format upon request.
3. Poles: Include information on maximum supported effective projected area (EPA) and weight for the design wind speed.

D. Samples:

1. Provide one sample(s) of each luminaire proposed for substitution upon request.
2. Provide one sample of each product finish illustrating color and texture upon request.

E. Certificates for Poles and Accessories: Manufacturer's documentation that products are suitable for the luminaires to be installed and comply with designated structural design criteria.

F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

G. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, handle, and store products according to NECA/IESNA 501 and manufacturer's written instructions.

B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.8 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

B. Provide five year manufacturer warranty for all LED luminaires, including drivers.

PART 2 PRODUCTS

2.1 LUMINAIRE TYPES

- A. Furnish products as indicated in luminaire schedule included on the drawings.
- B. Substitutions: See Section 016000 - Product Requirements.

2.2 LUMINAIRES

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.
- F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- G. Provide luminaires listed and labeled as suitable for wet locations unless otherwise indicated.
- H. Recessed Luminaires:
 - 1. Ceiling Compatibility: Comply with NEMA LE 4.
 - 2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
 - 3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.
- I. Hazardous (Classified) Location Luminaires: Listed and labeled as complying with UL 844 for the classification of the installed location.

J. LED Luminaires:

1. Components: UL 8750 recognized or listed as applicable.
2. Tested in accordance with IES LM-79 and IES LM-80.
3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

K. Exposed Hardware: Stainless steel.

2.3 POLES

A. All Poles:

1. Provide poles and associated support components suitable for the luminaire(s) and associated supports and accessories to be installed.
2. Structural Design Criteria:
 - a. Wind Load: Include effective projected area (EPA) of luminaire(s) and associated supports and accessories to be installed.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
- C. Verify that suitable support frames are installed where required.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 260533.16 as required for installation of luminaires provided under this section.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install products in accordance with manufacturer's instructions.
- D. Install luminaires in accordance with NECA/IESNA 501.
- E. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- F. Pole-Mounted Luminaires:
 - 1. Foundation-Mounted Poles:
 - a. Provide cast-in-place concrete foundations for poles as indicated, in accordance with Section 033000.
 - 1) Install anchor bolts plumb per template furnished by pole manufacturer.
 - 2) Position conduits to enter pole shaft.
 - b. Install foundations plumb.
 - c. Install poles plumb, using leveling nuts or shims as required to adjust to plumb.
 - d. Tighten anchor bolt nuts to manufacturer's recommended torque.
 - e. Install non-shrink grout between pole anchor base and concrete foundation, leaving small channel for condensation drainage.
 - f. Install anchor base covers or anchor bolt covers as indicated.
 - 2. Grounding:
 - a. Bond luminaires, metal accessories, metal poles, and foundation reinforcement to branch circuit equipment grounding conductor.
 - 3. Install separate service conductors, 12 AWG copper, from each luminaire down to handhole for connection to branch circuit conductors.
- G. Install accessories furnished with each luminaire.
- H. Bond products and metal accessories to branch circuit equipment grounding conductor.
- I. Install lamps in each luminaire.

3.4 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect each product for damage and defects.

- C. Operate each luminaire after installation and connection to verify proper operation.
- D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.5 ADJUSTING

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.
- B. Luminaires with Field-Rotatable Optics: Position optics according to manufacturer's instructions to achieve lighting distribution as indicated or as directed by Architect.

3.6 CLEANING

- A. Clean surfaces according to NECA/IESNA 501 and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals, for closeout submittals.
- B. Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.
- C. Just prior to Substantial Completion, replace all lamps that have failed.

3.8 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

END OF SECTION 265600

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SECTION 271000 - STRUCTURED CABLING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Communications system design requirements.
- B. Communications pathways.
- C. Copper cable and terminations.
- D. Fiber optic cable and interconnecting devices.
- E. Communications equipment room fittings.
- F. Communications outlets.
- G. Communications grounding and bonding.
- H. Communications identification.

1.2 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping.
- B. Section 260526 - Grounding and Bonding for Electrical Systems.
- C. Section 260536 - Cable Trays for Electrical Systems.
- D. Section 260533.16 - Boxes for Electrical Systems.
- E. Section 260553 - Identification for Electrical Systems: Identification products.
- F. Section 262726 - Wiring Devices.

1.3 REFERENCE STANDARDS

- A. BICSI N1 - Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure, 1st Edition; 2019.
- B. EIA/ECA-310 - Cabinets, Racks, Panels, and Associated Equipment; 2005e.
- C. ICEA S-83-596 - Indoor Optical Fiber Cable; 2021.

- D. ICEA S-90-661 - Category 3 and 5E Individually Unshielded Twisted Pairs, Indoor Cables (With or Without an Overall Shield) for Use in General Purpose and LAN Communication Wiring Systems; 2021.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. TIA-455-21 - FOTP-21 - Mating Durability of Fiber Optic Interconnecting Devices; 1988a (Reaffirmed 2012).
- G. TIA-492AAAD - Detail Specification for 850-nm Laser- Optimized, 50-?m Core Diameter/125-?m Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers Suitable for Manufacturing OM4 Cabled Optical Fiber; 2009.
- H. TIA-526-14 - Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant; Modification of IEC 61280-4-1 Edition 2, Fiber-Optic Communications Subsystem Test Procedures- Part 4-1: Installed Cable Plant-Multimode Attenuation Measurement; 2015c.
- I. TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set; 2020.
- J. TIA-568.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards; 2009c, with Addendum (2016).
- K. TIA-568.3 - Optical Fiber Cabling and Components Standard; 2016d.
- L. TIA-569 - Telecommunications Pathways and Spaces; 2019e.
- M. TIA-598 - Optical Fiber Cable Color Coding; 2014d, with Addendum (2018).
- N. TIA-606 - Administration Standard for Telecommunications Infrastructure; 2021d.
- O. TIA-607 - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises; 2019d.
- P. UL 444 - Communications Cables; Current Edition, Including All Revisions.
- Q. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers; Current Edition, Including All Revisions.
- R. UL 1651 - Fiber Optic Cable; Current Edition, Including All Revisions.
- S. UL 1863 - Communications-Circuit Accessories; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate requirements for service entrance and entrance facilities with Communications Service Provider.
2. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for communications equipment.
3. Coordinate arrangement of communications equipment with the dimensions and clearance requirements of the actual equipment to be installed.
4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
- C. Evidence of qualifications for installer.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.
- E. Test Plan: Complete and detailed plan, with list of test equipment, procedures for inspection and testing, and intended test date; submit at least 60 days prior to intended test date.
- F. Field Test Reports.
- G. Project Record Documents: Prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
 1. Record actual locations of outlet boxes and distribution frames.
 2. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
 3. Identify distribution frames and equipment rooms by room number on drawings.
- H. Operation and Maintenance Data: List of all components with part numbers, sources of supply, and operation and maintenance instructions; include copy of project record documents.

1.6 QUALITY ASSURANCE

- A. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- B. Manufacturer Qualifications: At least 3 years experience manufacturing products of the type specified.

- C. Installer Qualifications: A company having at least 3 years experience in the installation and testing of the type of system specified, and:
 - 1. Employing a BICSI Registered Communications Distribution Designer (RCDD).
 - 2. Supervisors and installers factory certified by manufacturers of products to be installed.
 - 3. Employing BICSI Registered Cabling Installation Technicians (RCIT) for supervision of all work.
- D. Products: Listed, classified, and labeled as suitable for the purpose intended.
- E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Keep stored products clean and dry.

1.8 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a 2 year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.1 SYSTEM DESIGN

- A. Provide a complete permanent system of cabling and pathways for voice and data communications, including cables, conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlets.
 - 1. Comply with TIA-568 (SET) (cabling) and TIA-569 (pathways) (commercial standards).
 - 2. Provide fixed cables and pathways that comply with NFPA 70 and TIA-607 and are UL listed or third party independent testing laboratory certified.
 - 3. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.
 - 4. In this project, the term plenum is defined as return air spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.
- B. System Description:
 - 1. Building Entrance Cable: By others.
 - 2. Backbones - Within Building: Fiber optic, 6-strand Singlemode, OS2 fiber optic cable and 24 strand Multimode, OM4 fiber optic cable.

3. Provide additional outlets where indicated on drawings.

- C. Main Distribution Frame (MDF): Centrally located support structure for terminating horizontal cables that extend to telecommunications outlets, functioning as point of presence to external service provider.
- D. Intermediate Distribution Frames (IDF): Support structures for terminating horizontal cables that extend to telecommunications outlets.
 - 1. Locate intermediate distribution frames as indicated on the drawings.
- E. Backbone Cabling: Cabling, pathways, and terminal hardware connecting intermediate distribution frames (IDF's) with main distribution frame (MDF), wired in star topology with main distribution frame at center hub of star.
- F. Cabling to Outlets: Specified horizontal cabling, wired in star topology to distribution frame located at center hub of star; also referred to as "links".

2.2 PATHWAYS

- A. Cable Trays: See Section 260536.
- B. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.
 - 1. Products:
 - a. HoldRite, a brand of Reliance Worldwide Corporation; HydroFlame Pro Series/HydroFlame Custom Built: www.holdrite.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.

2.3 COPPER CABLE AND TERMINATIONS

- A. Manufacturers:
 - 1. Hubbell Nextspeed.
 - 2. Substitutions: See Section 016000 - Product Requirements.
- B. Copper Horizontal Cable:
 - 1. Description: 100 ohm, balanced twisted pair cable complying with TIA-568.2 and listed and labeled as complying with UL 444.
 - 2. Cable Type - Voice and Data: TIA-568.2 Category 6A UTP (unshielded twisted pair); 23 AWG.
 - 3. Cable Capacity: 4-pair.
 - 4. Cable Applications:
 - a. Plenum Applications: Use listed NFPA 70 Type CMP plenum cable.
 - b. Riser Applications: Use listed NFPA 70 Type CMR riser cable or Type CMP plenum cable.
 - c. General Purpose Applications: Use listed NFPA 70 Type CM/CMG general purpose cable, Type CMR riser cable, or Type CMP plenum cable.

- 5. Cable Jacket Color - Voice and Data Cable: Blue.
- C. Copper Cable Terminations: Insulation displacement connection (IDC) type using appropriate tool; use screw connections only where specifically indicated.
- D. Jacks and Connectors: Modular RJ-45, non-keyed, terminated with 110-style insulation displacement connectors (IDC); high impact thermoplastic housing; suitable for and complying with same standard as specified horizontal cable; UL 1863 listed.
 - 1. Performance: 500 mating cycles.
 - 2. Voice and Data Jacks: 8-position modular jack, color-coded for both T568A and T568B wiring configurations.
- E. Copper Patch Cords:
 - 1. Description: Factory-fabricated 4-pair cable assemblies with 8-position modular connectors terminated at each end.
 - 2. Patch Cords for Patch Panels:
 - a. Quantity: One for each pair of patch panel ports.
 - b. Length: 3 feet.

2.4 FIBER OPTIC CABLE AND INTERCONNECTING DEVICES

- A. Manufacturers:
 - 1. Hubbell.
 - 2. Substitutions: See Section 016000 - Product Requirements.
- B. Fiber Optic Backbone Cable:
 - 1. Description: Tight buffered, non-conductive fiber optic cable complying with TIA-568.3, TIA-598, ICEA S-83-596 and listed as complying with UL 444 and UL 1651.
 - 2. Cable Type: Multimode, laser-optimized 50/125 um (OM4) complying with TIA-492AAADE.
 - 3. Cable Capacity: 6-fiber and 24-fiber.
 - 4. Cable Applications:
 - a. Plenum Applications: Use listed NFPA 70 Type OFNP plenum cable.
 - b. Riser Applications: Use listed NFPA 70 Type OFNR riser cable or Type OFNP plenum cable.
 - 5. Cable Jacket Color:
 - a. Laser-Optimized Multimode Fiber (OM5): Aqua.
 - b. Single-Mode Fiber (OS2): Yellow.
- C. Fiber Optic Interconnecting Devices:
 - 1. Connector Type: Type LC.
 - 2. Connector Performance: 500 mating cycles, when tested in accordance with TIA-455-21.
 - 3. Maximum Attenuation/Insertion Loss: 0.3 dB.

D. Fiber Optic Patch Cords:

1. Description: Factory-fabricated 2-fiber cable assemblies with suitable connectors at each end.
2. Patch Cords for Patch Panels:
 - a. Quantity: One for each pair of patch panel ports.
 - b. Length: 3 feet.

2.5 COMMUNICATIONS EQUIPMENT ROOM FITTINGS

A. Copper Cross-Connection Equipment:

1. Manufacturers:
 - a. Hubbell.
 - b. Substitutions: See Section 016000 - Product Requirements.
2. Connector Blocks for Category 5e and Up Cabling: Type 110 insulation displacement connectors; capacity sufficient for cables to be terminated plus 25 percent spare.
3. Patch Panels for Copper Cabling: Sized to fit EIA/ECA-310 standard 19 inch wide equipment racks; 0.09 inch thick aluminum; cabling terminated on Type 110 insulation displacement connectors; printed circuit board interface.
 - a. Jacks: Non-keyed RJ-45, suitable for and complying with same standard as cable to be terminated; maximum 48 ports per standard width panel.
 - b. Capacity: Provide ports sufficient for cables to be terminated plus 25 percent spare.
 - c. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA-606.
 - d. Provide incoming cable strain relief and routing guides on back of panel.

B. Fiber Optic Cross-Connection Equipment:

1. Manufacturers:
 - a. Hubbell.
 - b. Substitutions: See Section 016000 - Product Requirements.
2. Patch Panels for Fiber Optic Cabling: Sized to fit EIA/ECA-310 standard 19 inch wide equipment racks; 0.09 inch thick aluminum.
 - a. Adapters: As specified above under FIBER OPTIC CABLE AND INTERCONNECTING DEVICES; maximum of 24 duplex adapters per standard panel width.
 - b. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA-606.
 - c. Provide incoming cable strain relief and routing guides on back of panel.
 - d. Provide rear cable management tray at least 8 inches deep with removable cover.
 - e. Provide dust covers for unused adapters.

C. Backboards: Interior grade plywood without voids, 3/4 inch thick; UL-labeled fire-retardant.

1. Size: As indicated on drawings.
2. Do not paint over UL label.

D. Equipment Frames, Racks and Cabinets:

1. Manufacturers:
 - a. Hubbell.
2. Component Racks: EIA/ECA-310 standard 19 inch wide.
3. Wall Mounted Racks: Steel construction, hinged to allow access to back of installed components.
4. Floor Mounted Racks: Aluminum or steel construction with corrosion resistant finish; vertical and horizontal cable management channels, top and bottom cable troughs, and grounding lug.
5. Freestanding Cabinets: Front and rear doors with locks; removable side panels with locks; vented top and rear door; adjustable leveling feet; cable access in roof and base; grounding bar.
6. Wall Mounted Cabinets: Front doors with locks, louvered side panels, top and bottom cable access, and ground lug.
7. Cabinets: Steel construction with corrosion resistant finish.
8. Locks: Keyed alike.

E. Cable Management:

1. Manufacturers:
 - a. Hubbell.
2. Product(s):

2.6 COMMUNICATIONS OUTLETS

A. Outlet Boxes: Comply with Section 260533.16.

1. Provide depth as required to accommodate cable manufacturer's recommended minimum conductor bend radius.
2. Minimum Size, Unless Otherwise Indicated:
 - a. Voice Only Outlets: 4 inch by 2 inch by 2-1/8 inch deep (100 by 50 by 54 mm) trade size.
 - b. Data or Combination Voice/Data Outlets: 4 inch square by 2-1/8 inch deep (100 by 54 mm) trade size.

B. Wall Plates:

1. Comply with system design standards and UL 514C.
2. Accepts modular jacks/inserts.
3. Capacity:
 - a. Voice Only Outlets: 4 ports.
 - b. Data or Combination Voice/Data Outlets: 4 ports.
4. Wall Plate Material/Finish - Flush-Mounted Outlets: Match wiring device and wall plate finishes specified in Section 262726.

2.7 GROUNDING AND BONDING COMPONENTS

A. Comply with TIA-607.

B. Comply with Section 260526.

2.8 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606.
- B. Comply with Section 260553.

2.9 SOURCE QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Factory test cables according to TIA-568 (SET).

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- A. Comply with latest editions and addenda of TIA-568 (SET) (cabling), TIA-569 (pathways), TIA-607 (grounding and bonding), BICSI N1, NFPA 70, and SYSTEM DESIGN as specified in PART 2.
- B. Comply with Communication Service Provider requirements.
- C. Grounding and Bonding: Perform in accordance with TIA-607 and NFPA 70.
- D. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.

3.2 INSTALLATION OF PATHWAYS

- A. Install pathways with the following minimum clearances:
 - 1. 48 inches from motors, generators, frequency converters, transformers, x-ray equipment, and uninterruptible power systems.
 - 2. 12 inches from power conduits and cables and panelboards.
 - 3. 5 inches from fluorescent and high frequency lighting fixtures.
 - 4. 6 inches from flues, hot water pipes, and steam pipes.
- B. Outlet Boxes:
 - 1. Coordinate locations of outlet boxes provided under Section 260533.16 as required for installation of telecommunications outlets provided under this section.
 - a. Mounting Heights: Unless otherwise indicated, as follows:
 - 1) Telephone and Data Outlets: 18 inches above finished floor.
 - 2) Telephone Outlets for Side-Reach Wall-Mounted Telephones: 54 inches above finished floor to top of telephone.
 - 3) Telephone Outlets for Forward-Reach Wall-Mounted Telephones: 48 inches above finished floor to top of telephone.

- b. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
- c. Provide minimum of 24 inches horizontal separation between flush mounted outlet boxes installed on opposite sides of fire rated walls.
- d. Unless otherwise indicated, provide separate outlet boxes for line voltage and low voltage devices.
- e. Locate outlet boxes so that wall plate does not span different building finishes.
- f. Locate outlet boxes so that wall plate does not cross masonry joints.

3.3 INSTALLATION OF EQUIPMENT AND CABLING

A. Cabling:

- 1. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable diameter.
- 2. Do not over-cinch or crush cables.
- 3. Do not exceed manufacturer's recommended cable pull tension.
- 4. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.

B. Service Loops (Slack or Excess Length): Provide the following minimum extra length of cable, looped neatly:

- 1. At Distribution Frames: 120 inches.
- 2. At Outlets - Copper: 12 inches.
- 3. At Outlets - Optical Fiber: 39 inches.

C. Copper Cabling:

- 1. Category 5e and Above: Maintain cable geometry; do not untwist more than 1/2 inch from point of termination.
- 2. For 4-pair cables in conduit, do not exceed 25 pounds pull tension.
- 3. Use T568B wiring configuration.

D. Fiber Optic Cabling:

- 1. Prepare for pulling by cutting outer jacket for 10 inches from end, leaving strength members exposed. Twist strength members together and attach to pulling eye.
- 2. Support vertical cable at intervals as recommended by manufacturer.

E. Wall-Mounted Racks and Enclosures:

- 1. Install to plywood backboards only, unless otherwise indicated.
- 2. Mount so height of topmost panel does not exceed 78 inches above floor.

F. Floor-Mounted Racks and Enclosures: Permanently anchor to floor in accordance with manufacturer's recommendations.

G. Floor-Mounted Enclosures: Connect adjacent cabinets together and remove interior side panels.

H. Identification:

1. Use wire and cable markers to identify cables at each end.
2. Use manufacturer-furnished label inserts, identification labels, or engraved wallplate to identify each jack at communications outlets with unique identifier.
3. Use identification nameplate to identify cross-connection equipment, equipment racks, and cabinets.

3.4 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Comply with inspection and testing requirements of specified installation standards.

C. Visual Inspection:

1. Inspect cable jackets for certification markings.
2. Inspect cable terminations for color coded labels of proper type.
3. Inspect outlet plates and patch panels for complete labels.
4. Inspect patch cords for complete labels.

D. Testing - Copper Cabling and Associated Equipment:

1. Test backbone cables after termination but before cross-connection.
2. Test backbone cables for DC loop resistance, shorts, opens, intermittent faults, and polarity between connectors and between conductors and shield, if cable has overall shield.
3. Test operation of shorting bars in connection blocks.
4. Category 5e and Above Backbone: Perform near end cross talk (NEXT) and attenuation tests.

E. Testing - Fiber Optic Cabling:

1. Backbone: Perform optical fiber end-to-end attenuation test using an optical time domain reflectometer (OTDR) and manufacturer's recommended test procedures; perform verification acceptance tests and factory reel tests.
2. Multimode Backbone: Perform tests in accordance with TIA-526-14.

F. Final Testing: After all work is complete, including installation of telecommunications outlets, and telephone dial tone service is active, test each voice jack for dial tone.

END OF SECTION 271000

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SECTION 281300 – ACCESS CONTROL SYSTEM – REISSUED AD#3

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Access Control Software.
 - 2. Access Control Software Collaborations.
 - 3. Access Control Hardware Software Integrations.
 - 4. Access Control Software Interface.
 - 5. Access Control Software Administration.
 - 6. Accessory Software Schedule.
- B. Related Sections:
 - 1. Section 087100 - Door Hardware
- C. Definitions:
 - 1. Anti Passback (APB): A security measure that aims to prevent consecutive entries for one access card or prevent multiple people from using the same access card.
 - 2. Open Supervised Device Protocol (OSDP): An access control communications standard.
 - 3. Secure Copy Protocol (SCP): A means of securely transferring computer files between a local host and a remote host or between two remote hosts.
 - 4. Software Development Kit (SDK): A collection of software development tools in one installable package.
 - 5. Video Management System (VMS): A component of a security camera system that collects video from cameras and other sources, records and stores that video to a storage device, and provides an interface to both view the live video, and access recorded video.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate with Owner or Owner's representative regarding network configuration and estimated bandwidth utilization prior to performing network connections.
- B. Sequencing / Scheduling: Provide to Owner or Owner's representative a schedule and list of participants required to attend coordination and progress update meetings.
 - 1. Owner representative(s) for Facilities Management, Information Technology (IT) Services, and Security Management.
 - 2. General Contractor.
 - 3. Project Manager.
 - 4. Manufacturer's Representative.
 - 5. Project Architect.
 - 6. Security Consultant.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Data: Manufacturer's product information and data sheets for each product specified in this section, including:
 - 1. System overview drawings.
 - 2. Typical installation means and methods.
 - 3. Recommendations and requirements for proper storage and handling.
- B. Shop Drawings:
 - 1. Submit Manufacturer's approved shop drawings detailing the section and elevation views of each product to be installed.
 - 2. Coordinate with locations listed on Contract Drawings.
- C. Warranty Information:
 - 1. Submit confirmation and details of manufacturer's warranty, extended warranty, and replacement policies.
- D. System Support Resources:
 - 1. Submit a list of available manufacturers providing fee based professional services available to the Contractor or Owner, including but not limited to the following:
 - (a) Training.
 - (b) Installation.
 - (c) Commissioning.
 - (d) Remote diagnostics and integration with 3rd party software and hardware systems.

1.4 CLOSEOUT SUBMITTALS

- A. Supply licensing and registration information for all software, hardware, firmware, operational, and administrative licenses.
- B. Supply network configuration backup files, restoration application and instructions.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Provide products from manufacturer(s) with a minimum of 5 years in manufacturing access control specified in this section.
- B. Supplier Certifications: Provide products from a supplier in compliance with the following:
 - 1. Department of Homeland Security Safety Act Certified.
 - 2. NISPOM Compliance (National Industrial Security Program Operating Manual).
 - 3. HSPD-12 and FIPS201-2 Certified.
 - 4. GSA Approved product list.
- C. Installer Qualifications:
 - 1. Installer must be licensed to install access control and security equipment as required by authority having jurisdiction.
 - 2. Installer must have certified staff on access control products prior to bid date.
 - 3. Installer must be in good standing by the manufacturer prior to bid date.
 - 4. Installer must be capable of providing references that will attest to successful completion of projects of similar scope as the work noted in this section.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design Manufacturer: Avigilon.
 - 1. Address: 415 E Exchange Pkwy, Allen, TX 75002
 - 2. Phone: (888) 281-5182.
 - 3. Website: www.avigilon.com
- A. Manufacturer List: Extend existing system.
 - 1. Avigilon.
- B. Substitution Limitations:
 - 1. Substitutions are not permitted.

2.2 ACCESS CONTROL SOFTWARE

- A. Extend existing system.

2.3 ACCESS CONTROL SOFTWARE COLLABORATIONS

- A. Database Collaborations and Integrations: Provide access control software capable of integration with the following industry standard third-party databases.
 - 1. Bidirectional:
 - (a) REST API Integration.
 - 2. Pull Only:
 - (a) Lightweight Directory Access Protocol (LDAP/Active Directory).
 - (b) Structured Query Language (SQL) Server.
 - (c) Oracle Relational Database Management System (RDBMS).
 - (d) Comma Separated Value (CSV).
 - 3. Push Only:
 - (a) Extensible Markup Language (XML) for Event Push.
- B. Visitor Management Integration:
 - (a) HID Global: Easy Lobby.
 - (b) Splan.
 - (c) Envoy.
 - (d) Savance.
 - (e) Alert Enterprise.
- C. Custom Integrations
 - 1. Custom Integrations using RestAPI (as needed for project requirements)
- D. Video Integrations: Coordinate integration and unification requirements with 28 05 45.
 - 1. Avigilon Control Center.
 - 2. Milestone Xprotect.
 - 3. Johnson Controls ExacqVision.
 - 4. Pelco VideoXpert.

2.4 ACCESS CONTROL HARDWARE INTEGRATIONS

- A. Panel Hardware:
 - 1. Mercury: Controllers; Series 3 (LP1501, LP1502, LP2500, and LP4502).
 - 2. Mercury: Controllers; Series 2 (EP1501, EP1502, and EP2500).
 - 3. Mercury: Controllers; Legacy (SCP, SCP-C, and SCP-E).

4. Mercury: Sub Panels; MR50, MR52, MR16IN, MR16OUT, MR51E, and MR62E).
 5. Mercury: Conversion Boards; M5 Bridge.
 6. Mercury: Conversion Boards; MS Bridge.
 7. HID: Controllers; V2000 and V1000.
 8. HID: Sub Panels; V100, V200, and V300.
 9. Salto: Controllers; CU42E0XXX and CU4200XXX via SALTO SHIP integration to Pro Access Space.
 10. Schlage: GWE and PIM Modules.
 11. SimonsVoss: SmartIntego Series.
 12. Assa Abloy: Aperio Hubs.
 13. Assa Abloy: IPPOE .
- B. Supported Reader Hardware:
1. Readers capable of OSDP and Wiegand data format.
 2. HID: Prox.
 3. HID: R Series.
 4. HID: Signo.
 5. Allegion: Schlage Series.
 6. Farpointe: Pyramid.
 7. Farpointe: Delta.
 8. Farpointe: Conekt.
 9. Salto: XS4 Readers via SALTO SHIP integration to Pro Access Space.
 10. Assa Abloy: SN Line of readers.
 11. STid Readers.
- C. Credential Technologies:
1. Credentials capable of Open Card format (PROX, MiFare, DESFire CSN).
 2. HID Global: All Physical (SEOS, iClass, Prox, Mifare, DESFire) and Mobile (Origo).
 3. Schlage: All Physical (Mifare, Prox, DESFire).
 4. Farpointe Data: All Physical (Mifare/Prox) and Mobile.
 5. Salto Credentials: All Physical (MiFare/DESfire or SEOS, iClass) and Mobile (JustIN) via SALTO SHIP integration to Pro Access Space.
- D. Intrusion Detection Control Panels:
1. Bosch B series: (B3512, B4512, B5512, B6512, B8512G, B9512G).
 2. Bosch D Series: (D9412GV4, D9412GV4 V2).
 3. DMP (Digital Monitoring Products): XR150 & XR550.
- E. Biometrics:
1. Third party via Weigand or OSDP data format.
 2. ViRDI Biometrics: AC2000, AC5000.
 3. EyeLock.
 4. StoneLock.
 5. Suprema.
- F. Wireless Locksets:
1. Allegion/Schlage/Von Duprin: Wireless locksets.
 - a. RU & RM Crashbar
 - b. NDEB locks, including RS-485 gateway mode.
 - c. LEB locks, including RS-485 gateway mode.
 - d. Control Smart Deadbolt B/BM Locks (BE467F, FE410F).

- e. AD200.
- f. AD300.
- g. AD400.
- 2. Assa Abloy: Aperio.
 - a. IN100.
 - b. R100.
 - c. K100.
 - d. KS100.
 - e. ES100.
 - f. SN Series.
- 3. Assa Abloy: Gen 4 & 5 Hubs.
 - a. AH20.
 - b. AH30.
 - c. AH40.
- 4. Assa Abloy: Wi-Fi & POE via integration to DSR.
 - a. Sargent.
 - 1) Passport 1000 P1.
 - 2) Passport 1000 P2.
 - 3) Profile Series v.S1.
 - 4) Profile Series v.S2.
 - 5) IN120.
 - 6) IN220.
 - b. Corbin Russwin.
 - 1) Access 700 PIP1.
 - 2) Access 700 PWI1.
 - 3) Access 800 IP1.
 - 4) Access 800 WI1.
 - 5) IN120.
 - 6) IN220.
- 5. Salto Systems: Locks via SALTO SHIP integration to Pro Access Space.
- 6. SimonsVoss: SmartIntego Series.

G. Power Supplies: Provide one of the following power supplies that are manufacturer-prepared to support access control panels:

- 1. Life Safety Power
 - a. Unified Power: Mercury Security;
 - 1) Multi-door enclosures with or without network module
 - (a) Doors: 2.
 - (b) Doors: 4.
 - (c) Doors: 8.
 - (d) Doors: 16.
 - (e) Doors: 24.
 - b. ProWire Pre-Wired Power.
 - 1) Tie Wrapped multi-door enclosures.
 - (a) Doors: 4.
 - (b) Doors: 8.
 - (c) Doors: 16.
 - 2) Panduit multi-door enclosures with or without network module.
 - (a) Doors: 8.
 - (b) Doors: 16.

- (c) Doors: 24.
- c. Unified Power: Salto; multi-door enclosures with or without network module.
 - 1) Doors: 4.
 - 2) Doors: 6.
 - 3) Doors: 8.
 - 4) Doors: 10.
- H. US Federal Government FICAM Solution:
 - 1. HID pivCLASS Software Suite.
 - 2. HID pivCLASS PAM.
 - 3. HID pivCLASS Readers.
 - (a) SE Series.
 - (b) Signo Series.
 - 4. Mercury Embedded LP4502.
 - 5. Veridt PIV Readers.
 - 6. Assa Abloy FICAM Certified Locks.

2.5 ACCESS CONTROL SOFTWARE INTERFACE

- A. Web-Based Access Support: Provide access control software with browser-based access to system applications including support for industry standard desktop and mobile web browsers.
- B. Tabbed User Interface: System supports the following functionality in a tabbed view:
 - 1. Monitor events, alarms, and hardware status in real time.
 - 2. Verify identifies in real time.
 - 3. Search historical events and alarms.
- C. Events and Alarms: Provide system that allows administrators the ability to create, configure, and prioritize events and alarms and communicate information about the generation of the event or alarm to the operator with guidance for responding to the event or alarm. Events will support two levels: system level events affect all objects in the system; field level events affect only the object they are configured on.
- D. Access Groups: Provide system that allows administrators the ability to create groups of card readers and schedules such that card readers can allow or restrict access to areas based on schedules.
- E. Identity Records: Provide a system with integrated identity management, allowing imports of data from supported databases. Each identity supports access control based on groups and roles as well as individual overrides. Include functionality to customize identity and token forms in base software. Provide identity records capable of management and synchronization between multiple sites.
- F. Roles: Support a role-based permission method allowing one or more roles to be assigned to identities to determine physical and logical access.
- G. Anti-Passback: Provide access control software capable of designating areas to require a card to enter and exit the area before it is used to enter the area again.
 - 1. Soft and Hard Area APB: Tracks each badge that enters a specific area and defines which areas the badge may access next.

2. Door-Based APB: Tracks each badge that enters and does not allow the same badge to enter twice in a row until after the APB time limit is reached.
 3. Token-Based, Timed APB: Tracks each door a badge has accessed. After the badge has accessed one door, it must access a second door or wait until the APB time limit is reached before it may access the first door again.
 4. Timed Area APB: Time based hard area APB. When the time limit expires, the hard area APB becomes a soft area APB.
 5. Hard Door APB: Tracks each badge that enters a door and does not allow the same badge to enter twice in a row.
 6. Soft Door APB: Tracks each badge that enters a door and generates a warning transaction if the same badge is used at the same door twice in a row.
- H. Badging: Provide a tool to support the creation of custom badge layouts including the following content:
1. Static Information: Badge size, background color, text strings, and graphics common to every badge.
 2. Dynamic Information: Text fields and images from the identities database unique to each badge.
- I. Enrollment: Provide integrated identity management and enrollment functionality as part of the core system functionality.
1. Includes integration with HID Origo Credential Management or deployment of Origo mobile credentials directly from the access control web interface.
- J. Macros: Provide system capable of linking one or more events to macros such that a single event may execute up to 30 macros. System must support minimum of 255 macros per intelligent field controller.
- K. Device Template Configuration: Provide access control system that supports templates to automatically populate standard parameter fields in groups for new or existing doors, wires, readers, and input/output devices.
- L. Encryption: Provide access control system that supports the following encryption methods:
1. TLS 1.2: Require TLS encryption between the access control system and Mercury controller.
 2. Custom Certificates: Require self-signed or certificate authority certificate to harden access control system. Certificates will authenticate Mercury panels to the access control system.
 3. FIPS 140-2: Require access control server to utilize FIPS 140-2 compliant ciphers only.
 4. FIPS 201-2: Require large-encoded card formats for FIPS 201-2 certified pivClass solution.
- M. Custom Device Mappings: Administrators may assign a unique group of alarm attributes to specific device-alarm combinations to override global settings of generic attributes.
- N. Dashboard: Allow creation of a dashboard for real-time status and actions of hardware components on a single screen that can also filter by name, status, appliance, or group.
1. Hardware Status:
 - (a) Panels: Communication, power, tamper, and battery.
 - (b) Sub-Panels: Communication, power, and tamper.
 - (c) Inputs: Inactive, active, trouble, and masked.

- (d) Outputs: Off, on, and trouble.
 - (e) Doors: Communication, tamper, battery, unlocked, help, masked, and forced.
 - (f) Appliances: RAM, program, database, CPU load, and port status.
 - 2. Monitor:
 - (a) Panels: Device status, security status, name, model, firmware, IP address, MAC address, access port, callback port, cards in use, and last communication.
 - (b) Sub-Panels: Device status, name, panel, type, port, address, and firmware.
 - (c) Inputs: Device status, input name, subpanel, EOL resistance, and address.
 - (d) Outputs: Device status, output name, subpanel, schedule, and address.
 - (e) Power Supplies: Power supply name, installed status, status, and logs.
 - (f) Access Control Doors: Status, name, panel, door state, door mode, and override status.
 - 3. Manipulate Access Control Doors:
 - (a) Door actions: Grant, restore, unlock, locks no access, disable.
 - (b) Door mode: Card only, card and PIN, card or PIN, PIN only, facility code only, exit leaves open, toggle + exit leaves open.
 - (c) Door Forced: Mask forced, unmasked forced.
 - (d) Door Held: Masked held, unmasked held.
 - (e) Installed: Install, uninstall.
- O. Map Interface: Provide interface for creating customizable layouts including floorplans, reader locations, and buttons that can trigger actions.
 - 1. Actions: Card readers indicate alarm via icon and allow for card only, card and pin, card or pin, pin only, facility code only, disable, unlock, lock, grant, restore, mask held, unmask held, and trace actions.
 - 2. Occupancy/Mustering: Maps will provide real-time occupancy of a defined area.
 - 3. Programmable Buttons: Maps will provide mapping of buttons and text to perform actions.
- P. Verification Interface: Provide web-browser-enabled connection to access control software allowing a user to review information about card holders entering or existing up to four (4) doors in real time. Information to include badge photo, transaction time, and date via any device with a compatible browser.
- Q. Virtual Verification Station: Provide web-browser-enabled connection to the access control software to allow a user to visually confirm the identity and authorization of a person attempting entry to a controller area via a mobile device such as a tablet or smartphone.
- R. Intrusion Interface: Provide interface to see real-time status of linked Intrusion Panels.
 - 1. Display Intrusion Panels with following status:
 - (a) Communication, Battery, Power, Tamper, Phone Line.
 - 2. Display and Interact with Configured Areas.
 - (a) Status, Area Name, Panel Name.

- (b) Silence, Disarm, Master, and Perimeter.
- 3. Display and Interact with Intrusion Points.
 - (a) Status, Point, and Area.
 - (b) Bypass and Un-bypass.
- 4. Display and Interact with Intrusion Output.
 - (a) Status, Outpoint, Panel.
 - (b) Activate and Deactivate.
- S. Access Control Software Reporting: Generate, filter, edit, and customize system reports including the automated generation and distribution of customized reports in PDF and CSV formats.

2.6 ACCESS CONTROL MOBILE APPLICATION

- A. Basis of Design Product: ACM Expedite, by Motorola Solutions.
- B. Provide mobile app, compatible with Avigilon Unity Access platform, available on the following mobile platforms:
 - 1. Apple App Store.
 - 2. Google Play Store.
- C. Mobile Application Functionality:
 - 1. Changes made on Access Control system are dynamically reflected in Mobile app without Operator intervention.
 - 2. Realtime Door Status
 - (a) Browse any door to view its status and state.
 - 3. View and Control Doors
 - (a) Grant Access
 - (b) Review Transaction
 - 4. Identity Management
 - (a) Search for identities
 - (b) View identity profiles and change status
 - 5. Execute global actions with a single click:
 - (a) Lock Doors.
 - (b) Lockdown.
 - (c) Change Door Modes.
 - (d) Deactivate User Groups.
 - 6. Issue Door Commands.
 - 7. Review Door Transactions.
 - 8. Quick access to your favorite global actions and doors.
 - 9. Connection to multiple access control systems.

2.7 ACCESS CONTROL SOFTWARE VIDEO INTEGRATIONS.

- A. Video Management System Unification: Provide the following features in video management system when used in conjunction with access control software.
 - 1. Link cameras and doors on a single screen.
 - 2. Search video by card swipe identity last or first name using identity search.
 - 3. Grant door access.
 - 4. Monitor live door swipes with video for identity verification.
 - 5. Display video and alarm information in video management client.

- B. Access Control System: Provide the following features in access control software when used in conjunction with video management system.
 - 1. Link cameras and doors to specific events.
 - 2. Notifications for events includes live video and recording of even from before and after in web browser interface.

2.8 ACCESS CONTROL SOFTWARE ADMINISTRATION

- A. Backup: Provide access control software capable of backing up via USB drive, local appliance, windows network share, or secure copy protocol.
- B. Database Replication: Replicate database from 1 to 100 appliances for distributed identity control.
- C. Password Update: Provide ability for administrator to require operator update password at next login.
- D. Failover and Redundancy: Provide access control software that supports switching to backup system automatically in the event of a fatal failure without loss of monitoring or hardware control.
 - 1. Provide failover technology supporting LDAP data replication.
 - 2. Provide failover technology supporting either a 1:1 or N:1 architecture.
- E. Updates: Provide access control software capable of automatically updating the following:
 - 1. Operating System: Version, service packs, and security vulnerabilities.
 - 2. Field Devices: Firmware versions.
- F. Upgrade Functionality: Provide access control software capable of automatically upgrading software licensing.

2.9 ACCESSORY SOFTWARE SCHEDULE:

- A. Reader Licensing:
 - 1. Additional Readers: AC-SW-LIC-16RCU-6-P; perpetual, adds 16 reader software licenses to any appliance to expand door capacity up to the appliance's maximum capacity.
 - 2. Wireless Lock License AC-SW-LIC-WIRELESS-LOCK-6-P; required for all wireless locks not purchased from Access Control Manufacturer
- B. Badging Application Software Licenses:
 - 1. Badging Application: AC-SW-LIC-BDGE-6-P; perpetual, one per appliance.
- C. Video Integration Licenses:
 - 1. Exacq: AC-SW-LIC-EXACQ-6-P; perpetual, one per appliance.
 - 2. Milestone: AC-SW-LIC-MILEST-6-P; perpetual, one per appliance.
- D. Intrusion Integration Licenses:
 - 1. Bosch: AC-SW-LIC-BOSCHINTR-1PANEL-6-P; perpetual, per panel, one per appliance.
 - 2. Bosch: AC-SW-LIC-BOSCHINTR-10PANEL-6-P; perpetual, for 10 panels, one per appliance.
 - 3. DMP: AC-SW-LIC-DMPINTR-1PANEL-6-P; perpetual, per panel, one per appliance.

4. DMP: AC-SW-LIC-DMPINTR-10PANEL-6-P; perpetual, for 10 panels, one per appliance.
- E. Verify Integration Licenses:
 1. Verify: AC-SW-LIC-AVO-VER-5VS-6-P; perpetual, for five virtual stations, one per appliance.
 2. Verify: AC-SW-LIC-AVO-VER-16VS-6-P; perpetual, for sixteen virtual stations, one per appliance.
- F. Biometric Integration Licenses:
 1. VIRDI: AC-SW-LIC-VIRDI-BIO-6-P; perpetual, for Viridi Biometric readers, one per appliance.
- G. Redundancy and Failover Software Licenses
 1. Replication: AC-SW-LIC-REP-6-P; for multi-appliance replication, one per appliance.
 2. Auto Failover: AC-SW-LIC-AF-6-P; hot standby auto failover software license, one per appliance.
 3. Partitioning: AC-SW-LIC-PART-6-P; for additional partitions, one per appliance.
- H. IT Collaboration Software Licenses:
 1. Microsoft SQL: AC-SW-LIC-SQL-6-P; from Microsoft SQL Server 2000 forward, one per appliance.
 2. Oracle: AC-SW-LIC-ORCL-6-P; from Oracle DB 9i Server forward, one per appliance.
 3. LDAP Directory: AC-SW-LIC-LDAP-6-P; for Microsoft Active Directory or other, one per appliance.
 4. XML: AC-SW-LIC-XML-6-P; for XML events, one per appliance.
 5. REST: AC-SW-LIC-REST-6-P; perpetual, for unlocking REST-based API for custom integrations, one per appliance.

2.10 ACCESS CONTROL SERVER APPLIANCE

- A. General: Provide access control server appliance as part of an expandable, role-based physical access control system with the following functionality:
 1. Software: Provide access control system software in accordance with section 28 13 00.
 2. Integrations: Provide system compatible with third party open field hardware.
 3. Interface: Provides access from web browser to allow full access to alarms, events, hardware and history from multiple devices, including mobile devices.
 4. Coordination: Integrates with a network video management system to coordinate video alarm events and physical access system.
 5. Administration: Provides remote access and administrator control, failsafe performance through cloud-based server architecture, and best practices backup, update, and upgrade performance.

PART 3 EXECUTION

3.1 PREPARATION

- A. Prior to installation, ensure Access Control Hardware Appliance is capable of required Access Control Software Features and Integrations.

- B. Test system configuration(s) in accordance with instructions provided by manufacturer.

3.2 INSTALLATION

- A. Install system according to manufacturer's written instructions.
1. Develop, install, and test software and databases for complete and proper operation of systems involved. Activate and install all software and accessory software licenses.
 2. Setup and program entire system so that no additional programming is required after Substantial Completion, including setup of available software features.
 3. Perform a full system back-up at completion of initial programming and deliver configuration and transaction backups to Owner.
 4. Perform field software changes after the initial programming session to "fine tune" operating parameters and sequence of operations based on revisions to the Owner's operating requirements including the creation of time schedules, holidays, new card formats, etc. Create user hierarchy with access permissions. Set up notifications.
 5. Test equipment and configure system in accordance with instructions provided by manufacturer prior to installation.
- B. Ensure products are equipped with latest and most up-to-date firmware and/or software by manufacturer.
- C. Review configurable features of device with Owner's Representative and establish a punch list for standard, device specific, location specific and access control software-specific configuration of device(s).
- D. Program and configure devices in accordance with this punch list so no additional programming is required for operation by user.
- E. Configure equipment requiring users to log on using a password with user/site-specific password/passwords.
- F. No system/product default passwords allowed.

3.3 CLOSEOUT ACTIVITIES

- A. Demonstration:
1. Demonstrate administration and operation of access control system.
 2. Demonstrate how an authorized user can log in and make changes to configuration of card holders, door access, and run reports.
 3. Demonstrate how to operate functionality configured for this project as defined by configuration punch list.
 4. Demonstrate how to authorize users and applications to operate and configure installed devices.
- B. Fine Tuning:
1. Perform field software changes after initial programming session to "fine tune" operating parameters and sequence of operations based on any revisions to Owner's operating requirements.
- C. License Assignment:

1. Register software, hardware, firmware, operational or administrative licenses necessary for to operate or administer devices to Owner including the end user license agreement (EULA).
 2. Deliver to Owner's Representative proof of license registration from product manufacturer.
- D. System Adjustments:
1. Program and configure devices in accordance with the established punch list such that no additional programming is required for operation by user.
 2. Modify configurations as necessary to adjust operating parameters and sequence of operations based on the Owner's operating requirements.
- E. Device Configuration Backup:
1. Using access control system backup functionality, perform a full system backup at the completion of the initial programming to a USB drive or customer local network shared folder (preferred option). Schedule backup function to execute system backup periodically.
 2. Deliver configuration backup files, restoration application and instructions detailing for restoration of back-up configuration.

END OF SECTION 281300

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SECTION 284600 - FIRE DETECTION AND ALARM (WESTBROOK PARK ELEMENTARY SCHOOL)

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fire alarm system design and installation, including all components, wiring, and conduit.
- B. Transmitters for communication with supervising station.
- C. Replacement and removal of existing fire alarm system components, wiring, and conduit indicated.

1.2 RELATED REQUIREMENTS

- A. Section 083323 - Overhead Coiling Doors: Coiling fire doors to be released by fire alarm system.
- B. Section 087100 - Door Hardware: Electrically operated locks and door holder devices to be monitored and released by fire alarm system.
- C. Section 211300 - Fire-Suppression Sprinkler Systems: Supervisory, alarm, and actuating devices installed in sprinkler system.
- D. Section 233300 - Air Duct Accessories: Smoke dampers monitored and controlled by fire alarm system.

1.3 REFERENCE STANDARDS

- A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.
- B. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- C. IEEE C62.41.2 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (Corrigendum 2012).
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. NFPA 72 - National Fire Alarm and Signaling Code; Most Recent Edition Cited by Referring Code or Reference Standard.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Evidence of designer qualifications.
- C. Design Documents: Submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, riser diagrams, and description of operation:
 - 1. Copy (if any) of list of data required by authority having jurisdiction.
 - 2. NFPA 72 "Record of Completion", filled out to the extent known at the time.
 - 3. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A-7-5-2.2(9), and complete listing of software required.
 - 4. System zone boundaries and interfaces to fire safety systems.
 - 5. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.
 - 6. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.
 - 7. List of all devices on each signaling line circuit, with spare capacity indicated.
 - 8. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.
 - 9. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.
 - 10. Certification by either the manufacturer of the control unit or by the manufacturer of each other component that the components are compatible with the control unit.
 - 11. Certification by the manufacturer of the control unit that the system design complies with Contract Documents.
 - 12. Certification by Contractor that the system design complies with Contract Documents.
 - 13. Do not show existing components to be removed.
- D. Evidence of installer qualifications.
- E. Evidence of instructor qualifications; training lesson plan outline.
- F. Evidence of maintenance contractor qualifications, if different from installer.
- G. Inspection and Test Reports:
 - 1. Submit inspection and test plan prior to closeout demonstration.
 - 2. Submit documentation of satisfactory inspections and tests.
 - 3. Submit NFPA 72 "Inspection and Test Form," filled out.
- H. Operating and Maintenance Data: See Section 017800 for additional requirements; revise and resubmit until acceptable; have one set available during closeout demonstration:
 - 1. Complete set of specified design documents, as approved by authority having jurisdiction.

2. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.
 3. Contact information for firm that will be providing contract maintenance and trouble call-back service.
 4. List of recommended spare parts, tools, and instruments for testing.
 5. Replacement parts list with current prices, and source of supply.
 6. Detailed troubleshooting guide and large scale input/output matrix.
 7. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to Owner.
 8. Detailed but easy to read explanation of procedures to be taken by non-technical administrative personnel in the event of system trouble, when routine testing is being conducted, for fire drills, and when entering into contracts for remodeling.
- I. Project Record Documents: See Section 017800 for additional requirements; have one set available during closeout demonstration:
1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
 2. "As installed" wiring and schematic diagrams, with final terminal identifications.
 3. "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.
- J. Closeout Documents:
1. Certification by manufacturer that the system has been installed in compliance with manufacturer's installation requirements, is complete, and is in satisfactory operating condition.
 2. NFPA 72 "Record of Completion", filled out completely and signed by installer and authorized representative of authority having jurisdiction.
 3. Report on training results.
- K. Maintenance Materials, Tools, and Software: Furnish the following for Owner's use in maintenance of project.
1. See Section 016000 - Product Requirements, for additional provisions.
 2. Furnish spare parts of same manufacturer and model as those installed; deliver in original packaging, labeled in same manner as in operating and maintenance data and place in spare parts cabinet.
 3. In addition to the items in quantities indicated in PART 2, furnish the following:
 - a. All tools, software, and documentation necessary to modify the fire alarm system using Owner's personnel; minimum modification capability to include addition and deletion of devices, circuits, and zones, and changes to system description, operation, and evacuation and instructional messages.
 - b. One copy, on CD-ROM, of all software not resident in read-only-memory.
 - c. Extra Fuses: Two for each installed fuse; store inside applicable control cabinet.

1.5 QUALITY ASSURANCE

- A. Copies of Design Criteria Documents: Maintain at the project site for the duration of the project, bound together, an original copy of NFPA 72, the relevant portions of applicable codes, and instructions and guidelines of authorities having jurisdiction; deliver to Owner upon completion.
- B. Designer Qualifications: NICET Level III or IV (3 or 4) certified fire alarm technician or registered fire protection engineer, employed by fire alarm control panel manufacturer, Contractor, or installer, with experience designing fire alarm systems in the jurisdictional area of the authorities having jurisdiction.
- C. Installer Qualifications: Firm with minimum 3 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.
 - 1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.
 - 2. Installer Personnel: At least 2 years of experience installing fire alarm systems.
 - 3. Supervisor: NICET level III or IV (3 or 4) certified fire alarm technician; furnish name and address.
- D. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
- E. Instructor Qualifications: Experienced in technical instruction, understanding fire alarm theory, and able to provide the required training; trained by fire alarm control unit manufacturer.

1.6 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Provide control panel manufacturer's warranty that system components other than wire and conduit are free from defects and will remain so for 5 years after date of Substantial Completion.
- C. Provide installer's warranty that the installation is free from defects and will remain so for 1 year after date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Fire Alarm Control Units and Accessories:
 - 1. Existing Simplex 4100U

2. Provide control units made by the same manufacturer.
- B. Initiating Devices and Notification Appliances:
 1. Same manufacturer as control units.
 2. Provide initiating devices and notification appliances made by the same manufacturer, where possible.
- C. Substitutions: See Section 016000 - Product Requirements.
 1. For other acceptable manufacturers of control units specified, submit product data showing equivalent features and compliance with Contract Documents.
 2. For substitution of products by manufacturers not listed, submit product data showing features and certification by Contractor that the design will comply with Contract Documents.

2.2 FIRE ALARM SYSTEM

- A. Fire Alarm System: Provide modifications and extensions to the existing automatic fire detection and alarm system:
 1. Provide all components necessary, regardless of whether shown in Contract Documents or not.
 2. Protected Premises: Entire building shown on drawings.
 3. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
 - a. ADA Standards.
 - b. The requirements of the local authority having jurisdiction.
 - c. Applicable local codes.
 - d. Contract Documents (drawings and specifications).
 - e. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.
 4. Evacuation Alarm: Multiple smoke zones; allow for evacuation notification of any individual zone or combination of zones, in addition to general evacuation of entire premises.
 5. Voice Notification: Provide emergency voice/alarm communications with multichannel capability; digital.
 6. General Evacuation Zones: Each smoke zone is considered a general evacuation zone unless otherwise indicated, with alarm notification in all zones on the same floor, on the floor above, and the floor below.
 7. Program notification zones and voice messages as directed by Owner.
 8. Fire Command Center: Location indicated on drawings.
 9. Fire Alarm Control Unit: New, located at fire command center.
- B. Supervising Stations and Fire Department Connections:
 1. Public Fire Department Notification: Via existing system.
- C. Circuits:
 1. Initiating Device Circuits (IDC): Class B, Style A.

2. Signaling Line Circuits (SLC) Within Single Building: Class A, Style 7.
3. Notification Appliance Circuits (NAC): Class B, Style W.

D. Spare Capacity:

1. Initiating Device Circuits: Minimum 25 percent spare capacity.
2. Notification Appliance Circuits: Minimum 25 percent spare capacity.
3. Speaker Amplifiers: Minimum 25 percent spare capacity.
4. Fire Alarm Control Units: Capable of handling all circuits utilized to capacity without requiring additional components other than plug-in control modules.

E. Power Sources:

1. Primary: Dedicated branch circuits of the facility power distribution system.
2. Secondary: Storage batteries.
3. Capacity: Sufficient to operate entire system for period specified by NFPA 72.
4. Each Computer System: Provide uninterruptible power supply (UPS).

2.3 EXISTING COMPONENTS

- A. Existing Fire Alarm System: Remove existing components indicated and incorporate remaining components into new system, under warranty as if they were new; do not take existing portions of system out of service until new portions are fully operational, tested, and connected to existing system.
- B. Clearly label components that are "Not In Service."
- C. Remove unused existing components and materials from site and dispose of properly.

2.4 FIRE SAFETY SYSTEMS INTERFACES

- A. Supervision: Provide supervisory signals in accordance with NFPA 72 for the following:
 1. Sprinkler water control valves.
 2. Dry-pipe sprinkler system pressure.
 3. Dry-pipe sprinkler valve room low temperature.
- B. Alarm: Provide alarm initiation in accordance with NFPA 72 for the following:
 1. Sprinkler water flow.
 2. Kitchen hood suppression activation; also disconnect fuel source from cooking equipment.
 3. Duct smoke detectors.
- C. Elevators:
 1. Elevator lobby, hoistway, and machine room smoke detectors: Elevator recall for fire fighters' service.
 2. Elevator Machine Room Heat Detector: Shut down elevator power prior to hoistway sprinkler activation.

3. Sprinkler pressure or waterflow: Shut down elevator power prior to hoistway sprinkler activation.

D. HVAC:

1. Duct Smoke Detectors: Close dampers indicated; shut down air handlers indicated.

E. Doors:

1. Smoke Barrier Door Magnetic Holders: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor. Refer to Section 087100.
2. Electromagnetic Door Locks on Egress Doors: Unlock upon activation of any alarm initiating device or suppression system in smoke zone that doors serve as egress from. Refer to Section 087100.
3. Overhead Coiling Fire Doors: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor. Refer to Section 083323.

2.5 COMPONENTS

A. General:

1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.

- B. Fire Alarm Control Units: Analog, addressable type; listed, classified, and labeled as suitable for the purpose intended.

- C. Master Control Unit: Existing.

- D. Remote Annunciators: Existing.

E. Addressable Modules:

1. Provide addressable modules suitable for connection to fire alarm control unit signaling line circuits.
2. Unless otherwise indicated, use addressable modules only in clean, dry, indoor, nonhazardous locations.
3. Monitor Modules: Unless devices are explicitly permitted to be connected together as zone, provide separate addressable monitor module for each conventional dry-contact input device in order to be individually identifiable by addressable fire alarm control unit.
4. Control Modules: Provide as indicated or as required for selective control of notification appliances.
5. Releasing Control Modules: Provide as indicated or as required for control of listed solenoids in releasing applications.

6. Relay Modules: Provide as indicated or as required to perform necessary functions via dry-contact interface. Where load exceeds module contact rating, provide accessory power isolation relays suitable for load as required.
 7. Signaling Line Circuit (SLC) Isolating Modules: Provide as indicated or as required to automatically isolate short circuits on connected sections of SLC loops and allow other sections to continue to function normally. Provide automatic reset upon correction of short circuit.
- F. Initiating Devices:
1. Addressable Systems:
 - a. Addressable Devices: Individually identifiable by addressable fire alarm control unit.
 - b. Provide suitable addressable interface modules as indicated or as required for connection to conventional (non-addressable) devices and other components that provide a dry closure output.
- G. Circuit Conductors: Copper or optical fiber; provide 200 feet extra; color code and label.
- H. Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.
- I. Locks and Keys: Deliver keys to Owner.
1. Provide the same standard lock and key for each key operated switch and lockable panel and cabinet; provide 5 keys of each type
- J. Instruction Charts: Printed instruction chart for operators, showing steps to be taken when a signal is received (normal, alarm, supervisory, and trouble); easily readable from normal operator's station.
1. Frame: Stainless steel or aluminum with polycarbonate or glass cover.
 2. Provide one for each control unit where operations are to be performed.
 3. Obtain approval of Owner prior to mounting; mount in location acceptable to Owner.
 4. Provide extra copy with operation and maintenance data submittal.
- K. Storage Cabinet for Spare Parts and Tools: Steel with baked enamel finish, size appropriate to quantity of parts and tools.
1. Padlock eye and hasp for lock furnished by Owner.
 2. Locate as directed by Owner.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with applicable codes, NFPA 72, NFPA 70, and Contract Documents.
- B. Conceal all wiring, conduit, boxes, and supports where installed in finished areas.

- C. Obtain Owner's approval of locations of devices, before installation.
- D. Install instruction cards and labels.

3.2 INSPECTION AND TESTING FOR COMPLETION

- A. Notify Owner 7 days prior to beginning completion inspections and tests.
- B. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- C. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.
- D. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.
- E. Provide all tools, software, and supplies required to accomplish inspection and testing.
- F. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.
- G. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.
- H. Diagnostic Period: After successful completion of inspections and tests, Operate system in normal mode for at least 14 days without any system or equipment malfunctions.
 - 1. Record all system operations and malfunctions.
 - 2. If a malfunction occurs, start diagnostic period over after correction of malfunction.
 - 3. Owner will provide attendant operator personnel during diagnostic period; schedule training to allow Owner personnel to perform normal duties.
 - 4. At end of successful diagnostic period, fill out and submit NFPA 72 "Inspection and Testing Form."

3.3 OWNER PERSONNEL INSTRUCTION

- A. Provide the following instruction to designated Owner personnel:
 - 1. Hands-On Instruction: On-site, using operational system.
 - 2. Classroom Instruction: Owner furnished classroom, on-site or at other local facility.
- B. Administrative: One-hour session(s) covering issues necessary for non-technical administrative staff; classroom:
 - 1. Initial Training: 1 session pre-closeout.
 - 2. Refresher Training: 1 session post-occupancy.

- C. Basic Operation: One-hour sessions for attendant personnel, security officers, and engineering staff; combination of classroom and hands-on:
 - 1. Initial Training: 1 session pre-closeout.
 - 2. Refresher Training: 1 session post-occupancy.
- D. Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.
- E. Provide means of evaluation of trainees suitable to type of training given; report results to Owner.

3.4 CLOSEOUT

- A. Closeout Demonstration: Demonstrate proper operation of all functions to Owner.
 - 1. Be prepared to conduct any of the required tests.
 - 2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
 - 3. Have authorized technical representative of control unit manufacturer present during demonstration.
 - 4. Demonstration may be combined with inspection and testing required by authority having jurisdiction; notify authority having jurisdiction in time to schedule demonstration.
 - 5. Repeat demonstration until successful.
- B. Substantial Completion of the project cannot be achieved until inspection and testing is successful and:
 - 1. Specified diagnostic period without malfunction has been completed.
 - 2. Approved operating and maintenance data has been delivered.
 - 3. Spare parts, extra materials, and tools have been delivered.
 - 4. All aspects of operation have been demonstrated to Owner.
 - 5. Final acceptance of the fire alarm system has been given by authorities having jurisdiction.
 - 6. Specified pre-closeout instruction is complete.
- C. Perform post-occupancy instruction within 3 months after Substantial Completion.

3.5 MAINTENANCE

- A. See Section 017000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
- B. Perform routine inspection, testing, and preventive maintenance required by NFPA 72, including:
 - 1. Maintenance of fire safety interface and supervisory devices connected to fire alarm system.

2. Repairs required, unless due to improper use, accidents, or negligence beyond the control of the maintenance contractor.
 3. Record keeping required by NFPA 72 and authorities having jurisdiction.
- C. Provide trouble call-back service upon notification by Owner:
1. Provide on-site response within 2 hours of notification.
 2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
 3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.
- D. Provide a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.
- E. Maintain a log at each fire alarm control unit, listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced. Submit duplicate of each log entry to Owner's representative upon completion of site visit.
- F. Comply with Owner's requirements for access to facility and security.

END OF SECTION 284600

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SECTION 284600.1 - FIRE EMERGENCY COMMUNICATION ALARM SYSTEM (Beverly Hills Middle School, Drexel Hill Middle School, and Upper Darby High School)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The General Provisions of Contract, including General and Supplementary Conditions and other General Requirements sections, apply to the work specified in this section.

1.2 WORK DESCRIPTION:

- A. It is the intent of these specifications to update and expand the existing Simplex Addressable Fire Alarm system as shown on the Project Drawings to maintain compatibility and listing with all other existing Simplex Brand Fire Alarm equipment currently installed throughout the facility. All new initiating device circuit work shall use Simplex addressable material and IDNet addressable SLC communications. New Visuals shall be synchronized and Audible Signals shall be Voice Alarm capable. Simplex Brand is sold and supported by Johnson Controls JCI. JCI contact is Mr. Sam Stanitski (302) 419-5605 or samuel.stanitski@jci.com.
- B. The system expansion shall include a new 4100ES FACU expansion controller, new devices in accordance with the project drawings which may consist of new controls, pull stations, smoke/heat/duct sensors, annunciator panel, audio visual units, visual only units and any other appurtenances necessary for complete and operational system.
- C. The complete installation is to conform to the applicable sections of the current IBC, NFPA-72, NFPA-70 (with particular attention to Article 760), and any other locally enforced requirements of the Authority Having Jurisdiction.

1.3 QUALITY ASSURANCE:

- A. Each and all items of the Fire Alarm System shall be listed as a product of a single fire alarm system manufacturer under the appropriate category by Underwriters Laboratories, Inc. (UL), and shall bear the "U.L." label. Partial listing shall NOT be acceptable.
- B. The catalog numbers specified under this section are those of Simplex Time Recorder and constitute the type, product quality, material, and designed operating features. No substitutions will be acceptable.

1.4 SHOP DRAWINGS:

- A. The contractor shall submit a package which is sufficiently detailed to show that the proposed system meets the specifications. The package shall contain the following:

1. Catalog cuts of components, including system cabinets with physical dimensions.
2. Circuited Floor Plans showing the types and arrangement of connections among the components, including cable types.
3. Tabulations verifying the extra capacity required below. Show tabulations for points, power supplies, and battery standby.
4. Without these, the package will be rejected without review.

1.5 WARRANTY:

- A. The Contractor shall guarantee the system to perform as specified and be free from defects in materials and workmanship for one year from date of Owner acceptance. Any repairs during this time are to be provided by the Contractor during normal working hours at no cost to the Owner.

1.6 OPERATION:

- A. The actuation of any alarm initiating device such as a manual pull station, fire sensor or sprinkler flow switch shall cause the following to occur:
 1. Sound all audible and visual alarm signals until manually acknowledged and reset.
 2. Display the device in alarm label at the control panel.
 3. Display the device in alarm label at the annunciator panel if supplied.
 4. Transmit the alarm to the approved supervising station.

PART 2 - PRODUCTS

2.1 MAIN PANEL:

- A. Fire Alarm Master Controller CPU: Provide a new Simplex 4100ES FACU to expand the existing Fire Alarm Controls adding additional modules and enclosures as necessary to support the existing system. Where required demolish and/or consolidate existing legacy controls into modern 4100 ES type enclosures. At a minimum provide and power as noted the following in quantities necessary to complete the project:
 1. 4100-9600 Simplex 4100 U/ES expansion transponder.
 2. 4100-XXXX Simplex 4100 U/ES system power supply.
 3. 4100-XXXX Simplex 4100 U/ES expansion power supply.
 4. 4100-XXXX Simplex 4100 U/ES 100 W 70.7 VRMS amplifier.
 5. 4100-XXXX Related Support Modules as appropriate.

2.2 SYSTEM COMPONENTS

- A. TrueAlert Speaker/Visual Combination Alarm: Simplex 4906-9153 or 4906-9154
 1. White housing with a clear lens, wall mount
 2. Fully synchronized per ADA and UL Standard 1971

3. Strobe intensity shall be as indicated or required by the application (15/30/75/110 cd))
4. High quality voice and tone reproduction with multi-tap and capacitor input connection.
5. Surface-mount adapters where required (4905-9947)
6. Wire guards where indicated (4905-9998)

B. TrueAlert Speaker/Visual Combination Alarm for Aesthetic Installations

1. Same as item 2.2 A as modified by 2.2 B. 2.
2. Supply preinstalled in Concealite FA 900 Conceal-Alarm Series Fixture.
3. Fire notification appliance shall be wall mounted with operation controlled by the fire system. Upon system activation, the door of the fixture shall rotate 180 degrees and the fire notification appliance shall operate as required. Upon fire system reset, the door will rotate 180 degrees storing the appliance in the hidden position. Fixture shall be factory white powder coat finish paintable in the field. The fixture shall not affect or interfere with any diagnostic routines of the fire system. The unit shall be in conformance with NFPA 72 (National Fire Alarm Code).

C. TrueAlert Speaker Alarm: Simplex 4902-9721 with 2905-9946 Tile Bridge

1. Off-white housing, ceiling-mount
2. High quality voice and tone reproduction with multi-tap and capacitor input connection.

D. TrueAlert Visual Alarm: Simplex 4906-9103 or 4906-9104

1. White housing with a clear lens, wall-mount
2. Fully synchronized per ADA and UL Standard 1971
3. Strobe intensity shall be as indicated or required by the application (15/30/75/110 cd))
4. Surface-mount adapters where required (4905-9940)
5. Wire guards where indicated (4905-9961)

E. TrueAlert Visual Alarm for Weather-Proof: Simplex 4906-9105

1. Red housing with a clear lens, wall-mount
2. Fully synchronized per ADA and UL Standard 1971
3. Strobe intensity shall be as indicated or required by the application (15/60/75cd))
4. Surface Mount Weather-Proof Box (4905-9828)

F. IDNet Addressable Pull Station for ADA approved operation; Simplex #4099-9020

1. Single-action operation with ADA approved pull-to-operate actuation mechanism

2. Red Lexan housing with clearly visible operating instructions provided on the cover. The words FIRE ALARM shall appear on the front in white letters
 3. Key operated test-reset lock designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
 4. Surface Mount supply Box (2975-9178)
 5. Wire guards where indicated (2099-9800)
- G. IDNet Addressable Pull Station for Rugged/Vandal; Simplex #2099-9138 with 4090-9051
1. Single-action operation with pull-to-activate lever
 2. Red cast metal housing with clearly visible operating instructions provided on the cover. The words FIRE ALARM shall appear on the front in white letters
 3. Key operated test-reset lock designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
 4. Surface Mount supply Cast Aluminum Box (2975-9211)
- H. IDNet Addressable Pull Station for Weather-Proof; Simplex #2099-9144 with 4090-9051
1. Single-action operation pull-to-activate lever
 2. Red cast metal housing with clearly visible operating instructions provided on the cover. The words FIRE ALARM shall appear on the front in white letters
 3. Key operated test-reset lock designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
- I. Detection Devices – General
1. Sensors shall include analog sensing and addressable communication, and shall connect to the fire alarm control panel's Signaling Line Circuits.
 2. Sensors shall mount to the same addressable base which includes a status indicator LED.
 3. The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system.
 4. The sensors shall be ceiling-mount and shall include a separate twist-lock base which includes a tamper proof feature. Provide surface-mount adapter plate where required.
 5. The sensors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel.
- J. TrueAlarm Smoke Sensor (Photoelectric): Simplex #4098-9714
1. Shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
 2. Supply Standard Addressable Base Simplex #4098-9792 or Simplex #4098-9794 where Piezo Electric Sounder is specified.

- K. TrueAlarm Heat Sensor (Thermal); Simplex #4098-9733E
1. Thermal detectors shall be intelligent addressable devices rated to operate at 135 or 155 degrees Fahrenheit and be field-selectable with or without a rate-of-rise element rated at 15 degrees F per minute.
 2. Supply Standard Addressable Base Simplex #4098-9792E.
- L. TrueAlarm Multi-Sensor (Photoelectric with Thermal): Simplex #4098-9754
1. Shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density. Thermistor shall be self restoring and rate compensated.
 2. Supply Multi-Sensor Addressable Base Simplex #4098-9792 or Simplex #4098-9794 where Piezo Electric Sounder is specified.
- M. TrueAlarm Multi-Sensor (Photoelectric with Carbon Monoxide): Simplex #4098-9714/9746
1. Shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density. Electrolytic CO Toxic Gas Sensor.
 2. Supply CO Addressable Base Simplex #4098-9797 or Simplex #4098-9798 where Piezo Electric Sounder is specified.
- N. Air Aspiration Smoke Sensor: Simplex #VLC-600 with 2098-9808 Remote Status LED
1. Laser Detection Chamber type, featuring a high efficiency aspirator continually sampling air through a filtered transport system.
 2. The Housing shall be compact in size measuring 8-7/8" square and enclose the entire TrueAlarm Laser COMPACT sensor.
- O. Duct Smoke Sensor: Simplex #4098-9756 with 2098-9806 Test Station
1. Photoelectric type, with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied. Sensor includes relay as required for fan shutdown.
 2. The Duct Housing shall provide a supervised relay driver circuit for driving up to 15 relays with a single "Form C" contact rated at 7A@ 28VDC or 10A@ 120VAC. This auxiliary relay output shall be fully programmable. Mount relay within 3 feet of HVAC control circuit.
 3. Duct Housing shall have a transparent cover to monitor for the presence of smoke and a relay control trouble indicator Yellow LED and Red sensor status LED.

4. Duct Housing shall include two (2) Test Ports for measuring airflow and for testing. .
5. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to shutdown associated air handling system.
6. Each duct detector shall have a Remote Test Station with an alarm LED and test switch located where indicated.
7. Weatherproof Enclosure if indicated (4098-9845)

P. Addressable Interface (Monitor) Module; Simplex #4090-9001

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLCs.
2. The monitor module shall mount in a standard single-gang electrical box. Provide mounting bracket and cover plate with LED view port
3. The IDC zone shall be suitable for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
4. Supply mounting bracket Simplex # 4090-9810 with cover plate with LED light pipe for viewing Simplex # 4090-9807.

Q. Addressable Relay (Control) Module; Simplex # 4090-9002

1. Addressable Relay Modules shall be available for HVAC control and other building functions. The relay shall be form C and rated for a minimum of 2.0 Amps resistive or 1.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.
2. The control module shall mount in a standard 4-inch square, 2-1/8 inch deep electrical box, or to a surface mounted backbox.
3. Supply cover plate with LED light pipe for viewing Simplex # 4090-9802

R. Addressable Multi-Point Module (HVAC Dampers and other); Simplex # 4090-9118

1. Addressable Relay Modules shall be available for HVAC control and other building functions. The relay shall be form C and rated for a minimum of 2.0 Amps resistive or 1.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires. The input shall support the supervised monitoring of normally open, dry contacts in a "T-Sense" configuration.
2. The control module shall mount in a standard 4-inch square, 2-1/8 inch deep electrical box, or to a surface mounted backbox.
3. Supply cover plate with LED light pipe for viewing Simplex # 4090-9802

S. Non-Simplex Brand Components – General

1. Under certain circumstances the devices of other Manufacturer's may be required to satisfy environmentally challenging or special applications.
2. Conventional Heat Detection shall be products as manufactured by System Sensor.
3. Weatherproof Conventional Heat Detection shall be products as manufactured by Fire Detection Devices.
4. Linear Heat Detection Cable shall be products as manufactured by Protectowire or SafeCable.
5. Toxic Gas Detection shall be products as manufactured by MSA or Macurco.
6. Photo-Beam Detection shall be products as manufactured by Fire Fighting Enterprises or Xtralis.
7. These system Inputs shall be supervised as Conventional Initiating Device Zones via Panel Module or Addressable Module.
8. Weather Resistant/Proof Signaling shall be products as manufactured by Cooper Notification.
9. NEMA 4X Signaling shall be products as manufactured by MEDC.
10. Aftermarket add-on Relays shall be products as manufactured by Air Products and Controls.

T. Remote Annunciator Panel; Simplex # 4100-940X

1. Supervised remote annunciator with same look and feel as Primary Control Display including audible and visual indication of fire alarm by device, and audible and visual indication of system trouble.
2. Multi-line expanded content 320x240 dot matrix (QVGA) active event display screen with Bright white LED backlighting capable of displaying up to 854 characters.
3. English display: Indicates system normal with date and time during normal operation. Indicates type of alarm or trouble exact device with location, number of alarms with scrolling capability and supervisory conditions.
4. Six dedicated LED indicators: Power on, Alarm silence, System trouble, System supervisory, and Two alarm LED's.
5. Password protected.
6. LCD/lamp test button.
7. Control buttons: Alarm acknowledge, Supervisory acknowledge, Trouble acknowledge, Alarm silence. System reset, Scrolling next and previous, Seven programmable buttons for customized usage.
8. Mounting: Factory mounted in surface wall-mounted cabinet enclosure with key access. Simplex Platinum or Red finish.

U. Remote Voice Command Annunciator Panel; Simplex # 4100-940X

1. Supervised remote annunciator with same look and feel as Primary Control Display including audible and visual indication of fire alarm by device, and audible and visual indication of system trouble.
2. Multi-line expanded content 320x240 dot matrix (QVGA) active event display screen with Bright white LED backlighting capable of displaying up to 854 characters.
3. English display: Indicates system normal with date and time during normal operation. Indicates type of alarm or trouble exact device with location, number of alarms with scrolling capability and supervisory conditions.
4. Six dedicated LED indicators: Power on, Alarm silence, System trouble, System supervisory, and Two alarm LED's.
5. Password protected.
6. LCD/lamp test button.
7. Control buttons: Alarm acknowledge, Supervisory acknowledge, Trouble acknowledge, Alarm silence. System reset, Scrolling next and previous, Seven programmable buttons for customized usage.
8. Annunciator shall include both noise canceling microphone and remote master telephone.
9. Mounting: Factory mounted in surface wall-mounted cabinet enclosure with key access. Simplex Red finish.

V. System Expansion Transponder; Simplex # 4100-96XX

1. System hardware expansion shall occur collocated or remote of the Fire Alarm Master Controller using only system Transponders based on the same controls and enclosures used by the FACP.
2. System Expansion Transponder shall be Simplex 4100 ES MINIPLEX Type 4100-9600 Series.
3. Expansion Power Supplies shall be 4100 ES Type SPS, RPS, XPS, or TPS as dictated by the project requirements.
4. System Audio Expansion shall use the same 4100 ES Amplifier type as the Master Controller.

2.3 BATTERIES AND EXTERNAL CHARGER

A. Battery; Simplex # 2081-XXXX

1. Shall be 12 volt, Gel-Cell type.
2. Shall have sufficient capacity to power the fire alarm system for not less than twenty-four hours plus 15 minutes of alarm upon a normal AC power failure.
3. The batteries are to be completely maintenance free.

B. Battery Charger; Simplex# 4081-XXXX

1. Shall be completely automatic, with constant potential charger maintaining the battery fully charged under all service conditions. Charger shall operate from a 120/240-volt source.

C. Enclosure; Simplex# 4081-XXXX

1. Shall be of adequate volume to support external mounting of the battery reserve. Coordinate with supplier for proper selection and supply as necessary.

2.4 SPARE DEVICES; Simplex# BESAFEADDR

A. Provide the spare devices listed below in addition to all quantity of devices indicated on drawings. Deliver devices to Owner at conclusion of project.

1. One (1) sensor of each type
2. One (1) sensor base of each type
3. One (1) manual pull station of each type
4. One (1) interface module
5. One (1) control module
6. Two (2) speaker-visual devices
7. One (1) visual device

B. Extra material to be stored in a manufacturer approved and supplied spare parts kit. The enclosure shall be of adequate interior volume, be clearly labeled as to contents, and installed by the contractor in a readily accessible location for routine service activities.

2.5 CONDUIT AND WIRE/CABLE

A. Conduit and Raceway

1. Conduit shall be electrical metallic tubing, $\frac{3}{4}$ " minimum, with fittings and boxes as specified in Section 260533.
2. Refer to Part 3 for locations where conduit is required.

B. Wire and Cables

1. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system.
2. All fire alarm system wiring and cables must be new and be color-coded red
3. Number and size of conductors or cables shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG for initiating device circuits and signaling line circuits, and 14 AWG for notification appliance circuits.
4. Wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
5. Wire and cable not installed in conduit shall have a plenum-rated fire resistance rating as indicated in NFPA 70 (e.g., FPLR).
6. Conductors in conduit shall be type THHN or THWN insulated as specified in other Section 260519,

C. Terminal Boxes, Junction Boxes and Cabinets

1. All boxes and cabinets shall be factory painted red and UL listed for their use and purpose. Suppliers of such material include Arlington Industries, Bridgeport, Garvin, and Space Age Electronics.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with the NFPA 72, local and state codes, as shown on the drawings, and as recommended by the equipment manufacturer.
- B. Device Mounting: All fire detection and alarm system devices, control panels and remote annunciators shall be installed as follows:
 1. Accessible ceilings (lay-in ceilings or suspended drywall or similar construction)
 - a. flush mounted devices with recessed box and concealed wiring/conduit
 2. Inaccessible ceilings (exposed 'open' structure or inaccessible ceilings)
 - a. unfinished spaces; surface mounted devices using exposed conduit and boxes
 - b. finished spaces; surface mounted devices using surface raceway
 3. Hollow walls (stud walls or hollow CMU)
 - a. flush mounted devices with recessed box and concealed wiring in conduit
 - b. surface devices with exposed conduit may be used only in unfinished spaces (mechanical / electrical rooms or similar areas) or as approved by the Architect.
 4. Solid walls (solid masonry)
 - a. surface mounted devices with surface raceway system
 - 1) exposed conduit may be used only in unfinished spaces (mechanical / electrical rooms or similar areas as defined by the Architect)).

3.2 WIRING METHODS

- A. General: All fire alarm system wiring shall be installed concealed wherever possible.
 1. Install wiring in cable tray where indicated. Use an approved cable support system attached directly to structure elsewhere.
 2. No wiring shall lie directly on ceilings. No wiring shall be strapped or tied to piping, ductwork or conduits
 3. In open structure areas (rooms without ceilings) install wiring in conduit.
- B. Conduit and Raceway:
 1. All conduit and junction boxes shall be concealed in finished areas and may be exposed in unfinished areas or areas without ceilings (refer to 3.1.B).

2. Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer
3. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
4. All conduit, mounting boxes, junction boxes and panels are to be securely hung and fastened with appropriate fittings to insure positive grounding throughout the entire system.
5. Fire alarm cable must be separated from any open conductors of Power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, as per NEC Article 760-29. Wiring for 24 volt control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.
6. Conduit sleeves with fire-stopping shall be provided where open wiring penetrates floors or fire-rated partitions.

C. Wiring:

1. Wire and cable types and minimum size shall be as recommended by the equipment manufacturer. However, the size shall not be less than specified or shown on the drawing/riser diagram. The contractor shall not use any wire or cable not recommended by the equipment supplier.
2. The fire alarm control panel shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This panel circuit breaker shall be labeled as FIRE ALARM in "RED" and be provided with a "RED" Circuit Breaker Lock, Garvin UBL2 or equivalent. The control panel shall be grounded using a #10 AWG conductor.
3. Wiring used for the multiplex communication circuit (SLC) shall be twisted and unshielded and support a minimum wiring distance of 12,500 feet. The design of the system shall permit use of IDC and NAC wiring in the same conduit with the SLC communication circuit.
4. All field wiring shall be electrically supervised for open circuit and ground fault.
5. All conductors and cables shall be installed without the use of splices unless permitted by the manufacturer.
6. Cable lubricants shall be used only as permitted by the manufacturer.
7. Flexible connectors are to be used for all devices mounted in suspended lay-in ceiling panels
8. No wiring other than fire alarm detection, alarm or auxiliary functions will be permitted in fire alarm raceways.

D. Alarm Network Communications:

1. Digital Alarm Communicator and TCP/IP communications cable as specified in 2.3 J. 2. & 4. shall be Category 6 Plenum Rated Type. Cables shall be certified

to meet the ANSI/TIA -568-B.2-1 Standard for Gigabit Ethernet. Only 22 or 23 AWG copper shall be allowed. Work shall be completed in conformance with the Voice and Data Section.

2. Closed Loop Fire Alarm Network Communications shall be completed as an extension of the Voice and Data Section. Contractor to supply six (6) strands of 62.5/125 um Multi-mode Fiber Optical Cable or at the direction of the customer under the supervision and with the approval of SimplexGrinnell substitute Single Mode between the Fire Alarm Master Controller and customer's Building MDF. Fiber Optical Cable shall be broken out and connectorized on both ends. Connections on the MDF side shall match the other work. Connections on the FACP Side shall be ST Type. Breakout on the FACP side occur in its own Fiber Patch Panel within three (3) feet of the FACP and shall complete in the FACP on the Network Communications Media Module via Flexible Jumper. Where appropriate copper wire communications may be substituted if all work occurs within the same structure if approved by SimplexGrinnell and the customer.

E. Identification:

1. All wiring shall be identified at the FACP and at each terminal and junction box. Each conductor and cabinet terminal must be numbered and coded. All conductors in conduit pull boxes or cabinets containing more than one wire must be labeled on each end with machine printed on flexible high adhesion vinyl tape.
2. Wiring color codes must be used throughout. Transposing or changing color coding of wires will not be permitted.
3. Junction boxes shall be painted fire red and identified with 'FA' on cover. Suppliers of such material include Arlington Industries, Bridgeport, Garvin, and Space Age Electronics.

- F. Smoke detectors and pull stations shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect devices from contamination and physical damage

3.3 COORDINATION

- A. Coordinate with all other trades in submittal of shop drawings. Shop drawings shall detail space conditions to the satisfaction of all concerned trades, subject to final review by the architect or project manager whichever is applicable. If installation of equipment, raceways, cable trays and/or conduit is performed prior to coordination with other trades, which interferes with work of other trades, make necessary changes to correct the condition at no additional cost to the owner.
- B. Maintain all existing equipment and systems in operation until new equipment and systems are installed, tested and made operational as required, to follow phasing of construction.

- C. Coordinate and disconnect existing electronic/electrical equipment, services and/or controls to items being removed.

3.4 TEST

- A. Provide the service of a competent, factory-trained project manager NICET Level IV and technician NICET Level II minimum authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system.
 - 1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
 - 2. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.
 - 3. Verify activation of all flow switches.
 - 4. Open and ground initiating device and signaling line circuits and verify that the trouble signal actuates.
 - 5. Check presence and audibility of tone and voice message at all alarm notification devices.
 - 6. Check installation, supervision, and operation of all intelligent smoke detectors during a walk test.
 - 7. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.
 - 8. Test optional features based on the manufacturer's instructions.
- B. After certification of completion and operation of the system, the entire system shall be retested by the manufacturer's representative in the presence of a representative of the owner and the Authority Having Jurisdiction, and a test report per NFPA 72, shall be made out, in triplicate, and signed by the owner's representative, indicating that they witnessed the actual test of the system.

3.5 FINAL INSPECTION

- A. At the final inspection a factory trained representative of the manufacturer of the major equipment shall demonstrate that the systems function properly in every respect.

3.6 INSTRUCTIONS

- A. Furnish the services of a Simplex field representative who shall have specialized experience in the operation and maintenance of the systems and shall instruct the owner's personnel in the techniques involved in the operation of the systems.
- B. Formal on-site training shall be provided to the owner's representative/maintenance personnel and shall include instructions in the location, inspection, maintenance, testing and operation of all electronic components.

- C. Provide minimum of (4) hours of general instruction. Provide a signed copy of the name of the personnel giving the instructions and the personnel of the owner who were instructed.

3.7 WIRING:

- A. Wire and Cable shall be as recommended by the equipment manufacturer and approved for use as a Fire Alarm Cable by the National Fire Code and the local authority. Where exposed all circuits shall be enclosed in EMT or better. Installation shall follow Section 16100.
- B. Contractor shall supply two Category III rated (or better) UTP cables from the building's point of demarcation to the FACP to support a two channel alarm reporting connection. Installation shall follow Section 16100.
- C. The contractor shall supply two Category VI Cables between the customer's primary network service switch and the FACP to support IP Based Remote Service Monitoring and Reporting. Cables shall be certified to meet the ANSI/TIA -568-B.2-1 Standard for Gigabit Ethernet. Only 22 or 23 AWG copper shall be allowed. Installation shall follow Section 16100.

END OF SECTION 284600