

SECTION 04 01 00

BRICK REPAIR

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes repair of brick after removal of existing stucco and before installation of new stucco.
 - 1. Replacing damaged brick with new brick.
 - 2. Salvaging brick.
 - 3. Removing abandoned anchors.
 - 4. Repointing brick
- B. Related Requirements:
 - 1. Section 018316 "Exterior Enclosure General Requirements" for additional requirements related to the building enclosure, including but not limited to, the following:
 - a. Coordination of Work required to complete the exterior enclosure.
 - 2. Section 040141 "Stone Masonry Repair" for additional requirements related to the repair and replacement of terra cotta.

1.2 ALLOWANCES

- A. See Schedule of Brick Repairs at end of section.

1.3 UNIT PRICES

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

1.4 DEFINITIONS

- A. Rebuilding (Setting) Mortar: Mortar used to set and anchor masonry in a structure, distinct from pointing mortar installed after masonry is set in place.
- B. Saturation Coefficient: Ratio of the weight of water absorbed during immersion in cold water to weight absorbed during immersion in boiling water; used as an indication of resistance of bricks to freezing and thawing.

1.5 PRECONSTRUCTION TESTING

- A. Preconstruction Mortar Testing: Engage an independent testing agency/Conservation firm experienced in performing the type of tests indicated and acceptable to Architect to perform the following pre-construction tests
1. Analysis of existing pointing mortar; not less than 3 samples as directed by the Architect.
 2. Provide recommended replication mix to match color and texture of original mortar for each type of repointing mortar.
 3. Analysis to include:
 - a. Acid digestion and gravimetric analysis of sample to determine the constituents and ratios of sample.
 - b. Particle size analysis of aggregate, and recommendation of compatible aggregate for new mortar.
 - c. Recommendation for new bedding and pointing mixes compatible with existing masonry and mortar.
 - d. Samples of each recommended mortar in ½" by 6" channels.
 4. Deliver to the testing laboratory samples of the existing pointing mortar for analysis and verification of existing pointing mortar.
 5. Submit to the Architect copies of all test procedures, results, and repointing mortar mixes for review.
 6. Firms and laboratories which possess qualifications for analysis and for providing replication mixes include but are not limited to:
 - a. Keystone preservation Group. Doylestown, PA 267 261-8929
 - b. Building Conservation Associates, Inc. Philadelphia, PA 215.923.2834
- B. Brick mortar Tinting: test up to 4 colors of stain on (approximately 8" of mortar per test), in presence of Architect at a location selected by architect. Label each area with product used. Architect will select color to be used in larger mockup. Rake out and repoint the test area after completion of brick mortar tinting.

1.6 PREINSTALLATION MEETINGS

- A. Exterior Enclosure Coordination Workshops: Participate in workshops indicated in Division 01 Section "Exterior Enclosure General Requirements."
- B. Preinstallation Conference: Conduct conference at Project site
1. Review methods and procedures related to brick masonry repair including, but not limited to, the following:

- a. Verify brick masonry repair specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
- b. Materials, material application, sequencing, tolerances, and required clearances.
- c. Quality-control program.
- d. Coordination with other trades.

1.7 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include test data substantiating that products comply with requirements.

B. Shop Drawings:

1. Resetting units and their jointing and anchoring, showing relation of existing to new units.
2. Replacement and repair anchors, including drilled-in pins. Include details of anchors within individual units, with locations of anchors and dimensions of holes and recesses in masonry required for anchors, including direction and angle of holes for pins.

C. Samples: Include sets of Samples as necessary to show the full range of shape, color, and texture to be expected:

1. Brick: provide straps or panels containing at least four bricks. Include multiple straps for brick with a wide range.
2. Each type, color, and texture of pointing mortar in the form of sample mortar strips, 6 inches long by 1/4 inch wide, set in aluminum or plastic channels.
 - a. Include with each Sample a list of ingredients with proportions of each. Identify sources, both supplier and quarry, of each type of sand and brand names of cementitious materials and pigments if any.
3. Each type of masonry patching compound in the form of briquettes, at least 3 inches long by 1-1/2 inches wide. Document each Sample with manufacturer and stock number or other information necessary to order additional material.
4. Accessories: Each type of anchor, accessory, and miscellaneous support.

1.8 INFORMATIONAL SUBMITTALS

A. Qualification Data: For masonry repair specialist

B. Preconstruction Test Reports: For existing mortar and replacement bricks.

- C. Quality-control program.

1.9 QUALITY ASSURANCE

- A. Brick Masonry Repair Specialist Qualifications: Engage an experienced brick masonry repair firm to perform work of this Section. Firm shall have completed work similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance. Experience in only installing masonry is insufficient experience for masonry repair work.
1. Field Supervision: Brick masonry repair specialist firm shall maintain experienced full-time supervisors on Project site during times that brick masonry repair work is in progress.
 2. Brick Masonry Repair Worker Qualifications: When masonry is being patched, assign at least one worker per crew who is trained and certified by manufacturer of patching compound to apply its products
- B. Quality-Control Program: Prepare a written quality-control program for this Project to systematically demonstrate the ability of personnel to properly follow methods and use materials and tools without damaging masonry. Include provisions for supervising performance and preventing damage.
- C. Restoration Program: Prepare a written, detailed description of materials, methods, equipment, and sequence of operations to be used for each phase of restoration work including protection of surrounding materials and Project site.
- D. Mockups: Prepare mockups of brick masonry repair to demonstrate aesthetic effects and to set quality standards for materials and execution and for fabrication and installation.
1. New Brick: Prepare sample area comprising at least 8 adjacent units at location indicated by Architect. Erect sample areas in existing walls unless otherwise indicated, to demonstrate quality of materials, workmanship, and blending with existing work.
 2. Plug Repair: Two masonry plug repairs for brick.
 3. Brick Repointing: Rake out joints in 2 separate areas, each approximately 36 inches high by 48 inches wide for each type of repointing required and repoint one of the areas.
 4. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 5. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.10 DELIVERY, STORAGE, AND HANDLING

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

1.11 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit brick masonry repair work to be performed according to product manufacturers' written instructions and specified requirements.
- B. Temperature Limits: Repair brick masonry only when air temperature is above 40 deg F and is predicted to remain so for at least seven days after completion of the Work unless otherwise indicated.
- C. Hot-Weather Requirements: Protect masonry repairs when temperature and humidity conditions produce excessive evaporation of water from mortar and repair materials. Provide artificial shade and wind breaks, and use cooled materials as required to minimize evaporation. Do not apply mortar to substrates with temperatures of 90 deg F (32 deg C) and above unless otherwise indicated.
- D. For manufactured repair materials, perform work within the environmental limits set by each manufacturer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

2.2 MASONRY MATERIALS

- A. Face Brick: ASTM C 216 Grade SW. Provide units with surface texture, size, and shape to match existing brickwork.
 - 1. Initial Rate of Absorption: Less than 30 g/30 sq. in. per minute when tested per ASTM C 67.
 - 2. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
 - 3. Size: Match size of existing brick.
 - 4. Color. Match existing.
- B. Building (Common) Brick: ASTM C 62, Grade SW. Use only for areas not exposed to view.
 - 1. Unit Compressive Strength: same as face brick.
 - 2. Size: Match size of existing brick.
 - 3. Color. Match existing.

2.3 MORTAR MATERIALS

- A. Existing mortars are to be analyzed (see above) and mortar materials selected based on the recommendations of the analysis.
- B. Portland Cement: ASTM C 150, Type I or Type II, white or gray or both where required for color matching of exposed mortar.
 - 1. Provide cement containing not more than 0.60 percent total alkali when tested according to ASTM C 114.
- C. Hydrated Lime: ASTM C 207, Type S.
- D. Mortar Sand: ASTM C 144 unless otherwise indicated.
 - 1. Blend several sands if necessary to achieve suitable match.
- E. Water: Potable.

2.4 MORTAR MIXES

- A. Measurement and Mixing: Measure cementitious materials and sand in a dry condition by volume or equivalent weight. Do not measure by shovel; use known measure. Mix materials in a clean, mechanical batch mixer. Blend dry ingredients thoroughly before addition of water.
- B. Do not use admixtures in mortar unless otherwise indicated.

1. Mortar Proportions:

- a. Pointing Mortar: Mix mortar materials in the proportions recommended in mortar analyses
- b. Rebuilding (Setting) Mortar: Same as pointing mortar except mortar pigments are not required where bedding mortar is not visible.
- c. Pointing Mortar for brick: Type O ASTM C270 Proportion specification with cementitious material limited to portland cement and lime

C. Water: Potable, free of deleterious content.

2.5 ACCESSORY MATERIALS

- A. Anchors: Type and size indicated or, if not indicated, to match existing anchors in size and type. Fabricate anchors from Type 316 stainless steel.
- B. Masonry Repair Anchors, Spiral Type: Type 316 stainless-steel spiral rods designed to anchor to backing and veneer. Anchors are flexible in plane of veneer but rigid perpendicular to it.

1. Provide driven-in anchors designed to be installed in drilled holes and relying on screw effect rather than adhesive to secure them to backup and veneer.

- a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
- b. Hohmann & Barnard; Spira-Lok.
- c. Helifix; Dryfix

2.6 METAL FLASHING MATERIAL

- A. Comply with requirements of Section 076200.
- B. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304, dead soft, fully annealed 0.016 inch (0.40 mm) thick
- C. Fasteners: Series 300 stainless steel.
- D. Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.

1. Obtain field measurements for accurate fit before shop fabrication.
 2. Form sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
 3. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.
 4. Seams: Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
- E. Self-Adhering Sheet: Stainless steel fabric.
- F. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel bars, approximately 1 by 1/8 inch thick; with stainless steel anchors.

PART 3 - EXECUTION

3.1 PROTECTION

- A. Protect persons, motor vehicles, surrounding surfaces of building being restored, building site, plants, and surrounding buildings from harm resulting from masonry restoration work.
- B. Keep wall wet below area being cleaned to prevent streaking from runoff.

3.2 UNUSED ANCHOR REMOVAL

- A. Remove anchors, brackets, and other extraneous items no longer in use unless indicated to remain.
- B. Remove and replace bricks damaged by anchors except tight holes less than $\frac{3}{4}$ " diameter in unbroken bricks can be filled with pointing mortar.

3.3 BRICK REMOVAL AND REPLACEMENT

- A. At locations indicated, remove bricks. Remove and salvage entire units from joint to joint, without damaging surrounding masonry, in a manner that permits replacement with full-size units.
- B. Support and protect remaining masonry that surrounds removal area. Maintain flashing, reinforcement, lintels, and adjoining construction in an undamaged condition.
- C. Notify Architect of unforeseen detrimental conditions including voids, cracks, bulges, and loose units in existing masonry backup, rotted wood, rusted metal, and other deteriorated items.

- D. Clean bricks surrounding removal areas by removing mortar, dust, and loose particles in preparation for replacement.
- E. Clean salvaged bricks by removing mortar, dust, and loose particles in preparation for replacement.
- F. Replace removed brick with salvaged brick or with new brick matching existing brick, including size. Do not use broken units unless they can be cut to usable size.
- G. Install replacement brick into bonding and coursing pattern of existing brick. If cutting is required, use a motor-driven saw designed to cut masonry with clean, sharp, unchipped edges.
- H. Maintain joint width for replacement units to match existing joints.
- I. Use setting buttons or shims to set units accurately spaced with uniform joints.
- J. Lay replacement brick with completely filled bed, head, and collar joints. Butter ends with sufficient mortar to fill head joints and shove into place. Wet both replacement and surrounding bricks that have ASTM C 67 initial rates of absorption (suction) of more than 30 g/30 sq. in. per min. Use wetting methods that ensure that units are nearly saturated but surface is dry when laid.
 - 1. Tool exposed mortar joints in repaired areas to match joints of surrounding existing brickwork.
 - 2. When mortar is sufficiently hard to support units, remove shims and other devices interfering with pointing of joints.

3.4 PINNING

- A. At locations indicated install Spiral type masonry repair anchors through face of masonry. Install minimum of 2 anchors per unit unless noted otherwise.
- B. Recess anchors at least 5/8 inch from surface and fill recess with repair mortar.

3.5 FLASHING INSTALLATION

- A. General: Install sheet metal flashing and trim to comply with performance requirements and SMACNA's "Architectural Sheet Metal Manual" and Section 076200 Sheet Metal Flashing. Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
- B. Shop fabricate flashing per Section 076200.
- C. Install embedded 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.

3.6 REPOINTING BRICK MASONRY

- A. Rake out and repoint joints to the following extent:
 1. All joints in areas indicated.
- B. Rake out joints as follows, according to procedures demonstrated in approved mockup:
 1. Saturate surface with water to soften lime-based mortar and dislodge soil.
 2. Cut out mortar by hand with grout saw, chisel and resilient mallet
 3. Remove mortar from joints to depth of 2-3 times joint width, but not less than 1/2 inch or not less than that required to expose sound, unweathered mortar.
 4. Remove mortar from masonry surfaces within raked-out joints to provide reveals with square backs and to expose masonry for contact with pointing mortar. Brush, vacuum, or flush joints to remove dirt and loose debris.
 5. Do not spall edges of masonry units or widen joints.
- C. Notify Architect of unforeseen detrimental conditions including voids in mortar joints, cracks, loose masonry units, rotted wood, rusted metal, and other deteriorated items.
- D. Pointing with Mortar:
 1. Rinse joint surfaces with water to remove dust and mortar particles. Time rinsing application so, at time of pointing, joint surfaces are damp but free of standing water. If rinse water dries, dampen joint surfaces before pointing.
 2. Apply pointing mortar first to areas where existing mortar was removed to depths greater than surrounding areas. Apply in layers not greater than 1/4 inch until a uniform depth is formed. Fully compact each layer thoroughly and allow it to become thumbprint hard before applying next layer.
 3. After low areas have been filled to same depth as remaining joints, point all joints by placing mortar in layers not greater than 3/8 inch. Fully compact each layer and allow to become thumbprint hard before applying next layer. Where existing masonry units have worn or rounded edges, slightly recess finished mortar surface below face of masonry to avoid widened joint faces. Take care not to spread mortar beyond joint edges onto exposed masonry surfaces or to featheredge the mortar.
 4. When mortar is thumbprint hard, tool joints to match original appearance of joints as demonstrated in approved mockup. Remove excess mortar from edge of joint by brushing.
 5. Cure mortar by maintaining in thoroughly damp condition for at least 72 consecutive hours including weekends and holidays.

- a. Acceptable curing methods include covering with wet burlap and plastic sheeting, periodic hand misting, and periodic mist spraying using system of pipes, mist heads, and timers.
- 6. Hairline cracking within the mortar or mortar separation at edge of a joint is unacceptable. Completely remove such mortar and repoint.
- E. Where repointing work precedes cleaning of existing masonry, allow mortar to harden at least 30 days before beginning cleaning work.

3.7 FIELD QUALITY CONTROL

- A. Notify Architect's Project representatives in advance of times when lift devices and scaffolding will be relocated. Do not relocate lift devices and scaffolding until Architect's Project representatives have had reasonable opportunity to make inspections and observations of work areas at lift device or scaffold location.

3.8 BRICK REPAIR SCHEDULE

- A. For pricing assume the follow brick repairs: Actual scope of work to be determined in field and adjusted using Unit Prices.
 - 1. Rake out and repoint 50% of the brick joints.
 - 2. Replace 500 square feet of brick, one wythe deep, scattered across entire building, ranging from a single brick to larger areas. Where repairs are deeper than the outer wythe, each additional wythe of brick to be repaired shall be counted as additional square footage.
 - 3. Pin 500 new spiral anchors scattered across entire building.

END OF SECTION

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SECTION 04 01 10
MASONRY CLEANING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes maintenance of masonry as follows:
 - 1. Cleaning exposed masonry surfaces.
- B. Related Requirements:
 - 1. Section 018316 "Exterior Enclosure General Requirements" for additional requirements related to the building enclosure.
 - a. Coordination of Work required to complete the exterior enclosure.
 - 2. Section 040100 "Brick Repair.
 - 3. Section 040141 "Stone Masonry Repair.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate work of this section with adjacent components of the exterior enclosure. Participate in coordination required in Division 01 Section "Exterior Enclosure General Requirements".
- B. Preinstallation Meetings:
 - 1. Preinstallation Conference: Conduct conference at Project site.
- C. Exterior Enclosure Coordination Workshops: Participate in workshops indicated in Division 01 Section "Exterior Enclosure General Requirements."
- D. Sequencing / Scheduling: Comply with requirements specified in Division 1 Section "Exterior Enclosure General Requirements".

1.3 UNIT PRICES

- A. Work of this Section is affected by unit prices specified in Division 01 Section "Unit Prices."

1.4 DEFINITIONS

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

1.5 PRECONSTRUCTION TESTING

- A. Preconstruction Cleaning Testing: Engage an experienced masonry cleaning company to perform the following cleaning tests:
 - 1. Test each cleaning method indicated on an area not less than 20 square feet at location determined by Architect. Assume testing will be done from scaffolding or high reach. Perform tests with Architect or owner's representative present.
 - 2. For biocide cleaners apply the cleaner undiluted according to manufacturer's written instructions. Test cleaners with manufacturer representative present.
 - 3. Label all test areas and provide a detailed written description of each test
 - 4. Allow a waiting period of not less than seven days after completion of sample cleaning to permit a study of test areas for negative reactions.

1.6 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Restoration Program: Prepare a written, detailed description of materials, methods, equipment, and sequence of operations to be used for each phase of restoration work including protection of surrounding materials and Project site.
- C. Cleaning Program: Prepare a written cleaning program that describes cleaning process in detail, including materials, methods, and equipment to be used, protection of surrounding materials, and control of runoff during operations.
- D. Preconstruction test reports.

1.7 QUALITY ASSURANCE

- A. Restoration Specialist Qualifications: Engage an experienced, masonry restoration and cleaning firm to perform work of this Section. Firm shall have completed work similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance. Experience installing standard unit masonry is not sufficient experience for masonry restoration work.
 - 1. Field Supervision: Restoration specialist firms shall maintain experienced full-time supervisors on Project site during times that clay masonry restoration and cleaning work is in progress.

2. Restoration Worker Qualifications: Persons who are experienced in restoration work of types they will be performing
- B. Mockups: Prepare mockups of restoration and cleaning to demonstrate aesthetic effects and set quality standards for materials and execution and for fabrication and installation.
1. Masonry Cleaning:
 - a. Clean an area approximately 25 sq. ft. (2.3 sq. m) for each type of masonry. Adjust abrasive type, pressure, dwell time and standoff distance for each material to be cleaned to establish a desired level of cleanliness for each material
 - b. Clean another area approximately 25 sq. ft. (2.3 sq. m) for each type of masonry to serve as benchmark for cleaning.
 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. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in manufacturer's original and unopened containers, labeled with manufacturer's name and type of products.

1.9 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit restoration and cleaning work to be performed according to manufacturers' written instructions and specified requirements.
- B. Clean masonry surfaces only when air temperature is 40 deg F (4 deg C) and above and is predicted to remain so for at least 7 days after completion of cleaning.

PART 2 - PRODUCTS

2.1 CLEANING MATERIALS

- A. Water: Potable.
- B. Water Soak Cleaning:
1. hoses or plastic pipe with adjustable nozzles that will apply a fine water mist to entire surface being cleaned. Equip system with timers for intermittent spray.

- C. Micro-Abrasive Cleaning System: Comprised of air, water and an inert, micro-fine mineral powder applied at low pressure.
 - 1. Products: Subject to compliance with requirements, provide the following:
 - a. IBIX USA Historic Preservation (HP) Cleaning System.
- D. Biocide/Antimicrobial: Manufacturer's standard liquid formulation containing quaternary ammonium compounds, wetting agents, surfactants, and buffers, for removing fungi, bacteria, algae, lichen and moss from buildings and monuments. Biodegradable, pH 5.5 - 9.5, safe for landscaping plants and grass.
 - 1. Products: Subject to compliance with requirements, provide one of the following
 - a. D/2 Architectural Antimicrobial.
 - b. ProSoCo; Biowash.
- E. Paint Remover: manufactures standard non-acidic formula containing no methylene chloride and specifically recommended by manufacturer for removing paint from marble.

PART 3 - EXECUTION

3.1 PROTECTION

- A. Protect persons, motor vehicles, surrounding surfaces of building being restored, building site, plants, and surrounding buildings from harm resulting from masonry restoration work.
 - 1. Keep wall wet below area being cleaned to prevent streaking from runoff.

3.2 CLEANING MASONRY

- A. Clean all existing masonry that will be exposed in the finished work or is indicated for mineral silicate coating.
- B. Clean all existing masonry to be parged or tuck-pointed.
- C. Clean all existing masonry to receive mineral silicate coating.
- D. Proceed with cleaning in an orderly manner; work from top to bottom of each scaffold width and from one end of each elevation to the other. Ensure that dirty residues and rinse water will not wash over cleaned, dry surfaces.
- E. Use only those cleaning methods indicated for each masonry material and location.

1. Do not use wire brushes or brushes that are not resistant to chemical cleaner being used. Do not use plastic-bristle brushes if natural-fiber brushes will resist chemical cleaner being used.
 2. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that cleaning methods do not damage surfaces, including joints.
 - a. Equip units with pressure gages.
 - b. For chemical-cleaner spray application, use low-pressure tank or chemical pump suitable for chemical cleaner indicated, equipped with nozzle having a cone-shaped spray.
 - c. For water-spray application, use fan-shaped spray that disperses water at an angle of 25 to 50 degrees.
- F. Perform each cleaning method indicated in a manner that results in uniform coverage of all surfaces, including corners, moldings, and interstices, and that produces an even effect without streaking or damaging masonry surfaces.
- G. Micro-abrasive cleaning system:
1. Operator shall be trained and certified by Micro-abrasive cleaning system manufacturer
 2. Adjust abrasive type, pressure, dwell time and working distance for each material to be cleaned to achieve level of cleanliness established in mock-ups.
- H. Biocide/Antimicrobial: where indicated, apply Biocide/Antimicrobial according to Manufacturer's written instructions.
1. Apply Biocide/Antimicrobial by brush roller or sprayer.
 2. scrub surface with a non-metallic scrub brush
 3. Allow Biocide/Antimicrobial to dwell on surface according to Manufacturer's written instructions, applying new Biocide/Antimicrobial to maintain wet surface.
 4. Rinse with water applied at low pressure.
- I. -Water Soak:
1. Apply cold water by intermittent spraying to keep surface moist.
 2. Use perforated hoses or other means that will apply a fine water mist to entire surface being cleaned.
 3. Apply water in cycles of 30 minutes for spray with 30 minutes between cycles.
 4. Continue spraying until surface encrustation has softened sufficiently to permit its removal by water wash, as indicated by cleaning tests.
 - a. For Bid purposes assuming intermittent spraying for 24 hours.
 5. Remove soil and softened surface encrustation from stone with brushes and cold water applied by low-pressure spray.
- J. Paint Removal

1. Using plastic or wooden scrapers, remove as much of the coating mechanically.
 2. Ensure that all surfaces to be treated are clean of surface dirt and dry.
 3. Apply stripper to dry surfaces 1/8" to 1/4" thick, using a corrosion resistant, plastic trowels or non-metallic brushes. Work chemical coatings remover well into crevices.
 4. Allow the stripper to dwell as specified by the manufacturer or until all coatings has dissolved, whichever is the least amount of time. If leaving on the surface for several hours, a light polyethylene film or other moisture resistant material can be used to cover the chemical coatings remover on the walls. Press the polyethylene film against the chemical coatings remover so that it adheres. Tape or seal the edges of the polyethylene film.
 5. Do not allow the stripper to dry on the surface. If chemical coatings remover dries on the surface, mist the surface with water and allow chemical to remain on walls another 15 minutes until softened.
 6. Using corrosion resistant tools, carefully remove the chemical coatings remover and dissolved coatings by lifting, making sure the substrate is not scraped or gouged.
 7. Rinsing is to be performed with a fan tipped, water pressure washer, with pressures not to exceed 500psi.
 8. Multiple applications of the chemical coatings remover may be required to remove all of the coatings.
 9. If applicable, neutralize surface per manufactures' instructions.
- K. After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.

END OF SECTION

SECTION 04 01 41
STONE MASONRY REPAIR

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes maintenance of stone masonry as follows:
 - 1. Partial stone replacement
 - 2. Removing and resetting stone masonry
 - 3. Patching stone masonry
 - 4. Stone crack repair
 - 5. Replacing damaged stone with new stone
 - 6. Stone-fragment (incipient spall) repair.
 - 7. Raking and tuckpoint mortar joints in stone.
 - 8. Parging of existing stone foundations.
 - 9. Modification of existing stone for new construction.
- B. Related Requirements:
 - 1. Section 018316 "Exterior Enclosure General Requirements"
 - 2. Section 040141 "Brick Repair" for repair of brick under stucco.
 - 3. Section 040110 "Masonry Cleaning"

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate work of this section with adjacent components of the exterior enclosure. Participate in coordination required in Division 01 Section "Exterior Enclosure General Requirements".
- B. Preinstallation Meetings:
 - 1. Preinstallation Conference: Conduct conference at Project site.
- C. Exterior Enclosure Coordination Workshops: Participate in workshops indicated in Division 01 Section "Exterior Enclosure General Requirements."
- D. Sequencing / Scheduling: Comply with requirements specified in Division 1 Section "Exterior Enclosure General Requirements".

1.3 ALLOWANCES

- A. See Schedule of Stone Repairs at end of section.

1.4 UNIT PRICES

- A. Work of this Section is affected by unit prices specified in Division 01 Section "Unit Prices."

1.5 DEFINITIONS

- A. Rebuilding (Setting) Mortar: Mortar used to set and anchor masonry in a structure, distinct from pointing mortar installed after masonry is set in place.

1.6 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Templates: for new carved or profiled stone (anything not flat), provide templates taken from existing stone for architect's review before fabricating new stone.
- C. Masonry Repair Shop Drawings including the following:
 - 1. Include plans, elevations, sections, and locations of replacement and salvaged stone units. Show jointing and anchoring, show relation of existing adjacent stone to replacement and salvaged stone units.
 - 2. Show replacement and repair anchors, including drilled-in pins. Include details of anchors within individual units, with locations of anchors and dimensions of holes and recesses in masonry required for anchors, including direction and angle of holes for pins.
- D. Samples Include sets of Samples as necessary to show the full range of shape, color, and texture to be expected:
 - 1. Each type of masonry patching compound in the form of briquettes, at least 3 inches long by 1-1/2 inches wide. Document each Sample with manufacturer and stock number or other information necessary to order additional material.
 - 2. Stone Samples for Verification: Sets for each variety, color, and finish of stone required; not less than 12 inches square.
 - a. Sets shall consist of at least [four] Samples, exhibiting extremes of the full range of color and other visual characteristics expected and will establish the standard by which stone will be judged.
 - 3. Accessories: Each type of anchor, accessory, and miscellaneous support.
- E. Restoration Program: Prepare a written, detailed description of materials, methods, equipment, and sequence of operations to be used for each phase of restoration work including protection of surrounding materials and Project site.
- F. Preconstruction test reports.

1.7 PRECONSTRUCTION TESTING

- A. Preconstruction Mortar Testing: Engage an independent testing agency/Conservation firm experienced in performing the type of tests indicated and acceptable to Architect to perform the following pre-construction tests
1. Analysis of existing pointing mortar; not less than 3 samples as directed by the Architect.
 2. Provide recommended replication mix to match color and texture of original mortar for each type of repointing mortar.
 3. Analysis to include:
 - a. Acid digestion and gravimetric analysis of sample to determine the constituents and ratios of sample.
 - b. Particle size analysis of aggregate, and recommendation of compatible aggregate for new mortar.
 - c. Recommendation for new bedding and pointing mixes compatible with existing masonry and mortar.
 - d. Samples of each recommended mortar in ½" by 6" channels.
 4. Deliver to the testing laboratory samples of the existing pointing mortar for analysis and verification of existing pointing mortar.
 5. Submit to the Architect copies of all test procedures, results, and repointing mortar mixes for review.
 6. Firms and laboratories which possess qualifications for analysis and for providing replication mixes include but are not limited to:
 - a. Keystone preservation Group. Doylestown, PA 267 261-8929
 - b. Building Conservation Associates, Inc. Philadelphia, PA 215.923.2834
- B. Stone pointing mortar Tinting: test up to 4 colors of stain on (approximately 8" of mortar per test), in presence of Architect at a location selected by architect. Label each area with product used. Architect will select color to be used in larger mockup. Rake out and repoint the test area after completion of brick mortar tinting.

1.8 QUALITY ASSURANCE

- A. Restoration Specialist Qualifications: Engage an experienced, masonry restoration firm to perform work of this Section. Firm shall have completed work similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance. Experience installing standard unit masonry is not sufficient experience for masonry restoration work.

1. Field Supervision: Restoration specialist firms shall maintain experienced full-time supervisors on Project site during times that clay masonry restoration and cleaning work is in progress.
 2. Restoration Worker Qualifications: Persons who are experienced in restoration work of types they will be performing
- B. Mockups: Prepare mockups of restoration and cleaning to demonstrate aesthetic effects and set quality standards for materials and execution and for fabrication and installation.
1. Stone Patching: Three small holes at least **2 inch (50 mm)** in diameter for each type of masonry to be patched.
 2. Dutchman Repair: Two dutchman masonry plug repairs for each type of masonry indicated to be plugged.
 3. Crack Injection: Apply crack injection in 2 separate areas, each approximately **12 inches** long as directed.
 4. Stone Repointing: Rake out joints in 2 separate areas, each approximately 36 inches high by 48 inches wide for each type of repointing required and repoint one of the areas.
 5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 6. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver masonry units to Project site strapped together in suitable packs or pallets or in heavy-duty cartons.
- B. Deliver each stone with code mark or setting number on unexposed face, corresponding to Shop Drawings, using nonstaining paint.
- C. Deliver other materials to Project site in manufacturer's original and unopened containers, labeled with manufacturer's name and type of products.
- D. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- E. Store hydrated lime in manufacturer's original and unopened containers. Discard lime if containers have been damaged or have been opened for more than two days.
- F. Store lime putty covered with water in sealed containers.
- G. Store sand where grading and other required characteristics can be maintained and contamination avoided.

1.10 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit restoration and cleaning work to be performed according to manufacturers' written instructions and specified requirements.
- B. Repair masonry units and repoint mortar joints only when air temperature is between **40 and 90 deg F** and is predicted to remain so for at least 7 days after completion of the Work unless otherwise indicated.
- C. Hot-Weather Requirements: Protect patching and mortar-joint pointing when temperature and humidity conditions produce excessive evaporation of water from mortar and patching materials. Provide artificial shade and wind breaks and use cooled materials as required to minimize evaporation. Do not apply mortar to substrates with temperatures of **90 deg F** and above unless otherwise indicated.
- D. For manufactured repair materials, perform work within the environmental limits set by each manufacturer.
- E. Clean masonry surfaces only when air temperature is **40 deg F** and above and is predicted to remain so for at least 7 days after completion of cleaning.

PART 2 - PRODUCTS

2.1 MASONRY MATERIALS

- A. Stone General: Provide natural building stone of variety, color, texture, grain, veining, finish, size, and shape to match existing stone and with physical properties as listed below:
 - 1. For existing stone that exhibits a range of colors, texture, grain, veining, finishes, sizes, or shapes, provide stone that proportionally matches that range rather than stone that matches an individual color, texture, grain, veining, finish, size, or shape within that range.
 - 2. Quarrying New Stone: Have quarry clearly label the direction of bedding planes when rough stone is quarried, to facilitate cutting stones so that natural bedding planes will be as required in "Cutting New Stone" Paragraph.
 - 3. Cutting New Stone: Regardless of how existing stone was cut and set, cut each new stone so that, when it is set in final position, natural bedding planes are essentially horizontal.

2.2 MORTAR MATERIALS

- A. Existing mortars are to be analyzed (see above) and mortar materials selected based on the recommendations of the analysis.

- B. Portland Cement: ASTM C 150, Type I or Type II, white unless color matching of exposed mortar can be shown to match existing mortar.
 - 1. Provide cement containing not more than 0.60 percent total alkali when tested according to ASTM C 114.
- C. Hydrated Lime: ASTM C 207, Type S.
- D. Mortar Sand: ASTM C 144 unless otherwise indicated.
 - 1. Blend several sands if necessary to achieve suitable match.
- E. Mortar Tinting Materials: Permanent non-bleeding.
- F. Water: Potable.

2.3 MORTAR MIXES

- A. Measurement and Mixing: Measure cementitious materials and sand in a dry condition by volume or equivalent weight. Do not measure by shovel; use known measure. Mix materials in a clean, mechanical batch mixer. Blend dry ingredients thoroughly before addition of water.
- B. Do not use admixtures in mortar unless otherwise indicated.
 - 1. Mortar Proportions:
 - a. Pointing Mortar: Mix mortar materials in the proportions recommended in mortar analyses
 - b. Rebuilding (Setting) Mortar: Same as pointing mortar except mortar pigments are not required where bedding mortar is not visible.
 - c. Pointing Mortar for Stone: Type O ASTM C270 Proportion specification with cementitious material limited to portland cement and lime

2.4 MANUFACTURED REPAIR MATERIALS

- A. Stone Patching Compound: Factory-mixed cementitious product that is custom manufactured for patching stone.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cathedral Stone Products, Inc.; Jahn Restoration Mortars M70
 - b. Conproco Corporation; Mimic or Matrix.
 - c. Edison Coatings, Inc.; Custom System 45.

2. Use formulation that is vapor- and water permeable (equal to or more than the stone), exhibits low shrinkage, has lower modulus of elasticity than the stone units being repaired, and develops high bond strength to all types of stone.
 3. Use formulation having working qualities and retardation control to permit forming and sculpturing where necessary.
- B. Cementitious Crack Filler: An ultrafine superplasticized grout that can be injected into cracks, is suitable for application to wet or dry cracks, exhibits low shrinkage, and develops high bond strength to stone.
1. Products: provide one of the following:
 - a. Cathedral Stone Products, Inc.; Jahn M30 #32.
 - b. Limeworks Ecologi Injection Grout Type I
 - c. Conproco Corporation; injection grout.
- C. Anchor Setting Mortar: single-component, cementitious, non-shrinking mortar designed for securing anchors in masonry
- D. Stone Adhesive: 1-part cementitious stone adhesive, recommended by adhesive manufacturer for type of masonry repair indicated, and matching color.
1. Products: Subject to compliance with requirements, provide the following:
 - a. Cathedral Stone Products, Inc.; Jahn Restoration Adhesive.

2.5 ACCESSORY MATERIALS

- A. Anchors: Type and size indicated or, if not indicated, to match existing anchors in size and type. Fabricate anchors from Type 316 stainless steel.
- B. Masonry Repair Anchors, Spiral Type: Type 316 stainless-steel spiral rods designed to anchor to backing and veneer. Anchors are flexible in plane of veneer but rigid perpendicular to it.
1. Provide driven-in anchors designed to be installed in drilled holes and relying on screw effect rather than adhesive to secure them to backup and veneer.
 2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Hohmann & Barnard; Spira-Lok.
 - b. Helifix; Dryfix
- C. Setting Buttons: Resilient plastic buttons, nonstaining to masonry, sized to suit joint thicknesses and bed depths of masonry units without intruding into required depths of pointing materials.

PART 3 - EXECUTION

3.1 PROTECTION

- A. Protect persons, motor vehicles, surrounding surfaces of building being restored, building site, plants, and surrounding buildings from harm resulting from masonry work.

3.2 UNUSED ANCHOR REMOVAL

- A. Remove anchors, brackets, and other extraneous items no longer in use unless indicated to remain.
 - 1. Remove items carefully to avoid spalling or cracking masonry.
 - 2. Where directed, if an item cannot be removed without damaging surrounding stone, do the following:
 - a. Cut or grind off item approximately 1 inch beneath surface and core drill a recess of same depth in surrounding masonry as close around item as practical.
 - b. Immediately paint exposed end of item with two coats of antirust coating, following coating manufacturer's written instructions and without exceeding manufacturer's recommended dry film thickness per coat. Keep paint off sides of recess.
- B. Provide stone plug where each item was removed.

3.3 STONE REMOVAL AND REPLACEMENT

- A. At locations indicated, remove stone units. Cut out mortar joints without damaging stone or adjacent material. Carefully remove entire units from joint to joint, without damaging surrounding stone, in a manner that permits replacement with full-size units.
- B. Label all stones as they are removed with location keyed to drawing.
- C. Support and protect remaining stonework that surrounds removal area. Maintain flashing, reinforcement, lintels, and adjoining construction in an undamaged condition.
- D. Notify Architect of unforeseen detrimental conditions including voids, cracks, bulges, and loose masonry units in existing masonry backup, rotted wood, rusted metal, and other deteriorated items.
- E. Remove and salvage in an undamaged condition as many whole stone units as possible.
- F. Clean stone surrounding removal areas by removing mortar, dust, and loose particles in preparation for replacement.

- G. Install salvaged and replacement stone into bonding and coursing pattern of existing stone. If cutting is required, use a motor-driven saw designed to cut stone with clean, sharp, unchipped edges. Finish edges to blend with appearance of edges of existing stone.
1. Maintain joint width match existing joints.
 2. If necessary use setting buttons or shims to set stone accurately spaced with uniform joints.
- H. Set stone with completely filled bed, head, and collar joints. Butter vertical joints for full width before setting and set units in full bed of mortar unless otherwise indicated. Provide anchors with new anchors of size and type indicated.
1. Tool exposed mortar joints in repaired areas to match joints of surrounding existing stonework.

3.4 MASONRY UNIT PATCHING

A. Patching Stone

1. Patch stone units indicated:
2. Remove and replace existing patches where indicated.
3. Remove deteriorated material and remove adjacent material that has begun to deteriorate. Carefully remove additional material so patch will not have feathered edges but will have square or slightly undercut edges on area to be patched and will be at least **1/4 inch** thick, but not less than recommended by patching compound manufacturer.
4. Mask adjacent mortar joint or rake out for repointing if patch will extend to edge of stone unit.
5. Provide stainless steel threaded pins. Provide one pin per each 8 square inches of patch and at least one pin per patch. Set pins minimum 1 inch into masonry and provide minimum 1/2 inch cover.
6. Mix patching compound in individual batches to match each stone unit being patched. Combine one or more colors of patching compound, as needed, to produce exact match.
7. Brush-coat stone surfaces with slurry coat of patching compound according to manufacturer's written instructions.
8. Place patching compound as recommended by patching compound manufacturer.
 - a. Trowel, scrape, or carve surface of patch to match texture and surrounding surface plane or contour of the stone. Shape and finish surface before or after curing, as determined by testing, to best match existing stone.
 - b. Build patch up 1/4 inch (6 mm) above surrounding stone and carve surface to match adjoining stone after patching compound has hardened.
9. Keep each layer damp for 72 hours or until patching compound has set.

10. Remove and replace patches with hairline cracks or that show separation from stone at edges, and those that do not match adjoining stone in color or texture.

3.5 PARTIAL STONE REPLACEMENT (Dutchman)

- A. Remove defective portion of existing stone unit (backing stone). Carefully remove defective portion of stone by making vertical and horizontal saw cuts at face of backing stone and demolishing defective material to depth required for fitting partial replacement (dutchman).
 1. Make edges of backing stone at cuts smooth and square to each other and to finished surface; essentially rectangular. Make back of removal area flat and parallel to stone face.
 2. Do not overcut at corners and intersections. Hand trim to produce clean sharp corners with no rounding and no damage to existing work to remain.
 3. If existing stone that is to remain becomes damaged, remove damaged area and enlarge partial replacement as required.
- B. Remove mortar from joints that abut area of stone removal to same depth as stone was removed. Remove loose mortar particles and other debris from surfaces to be bonded and surfaces of adjacent stone units that will receive mortar by cleaning with stiff-fiber brush.
- C. Cut and trim partial replacement to accurately fit area where material was removed from backing stone. Fabricate to size required to produce joints between partial replacement and backing stone of no more than **1/16 inch** in width, and joints between partial replacement and other stones that match existing joints between stones.
- D. Concealed Pinning: Before applying adhesive, prepare for concealed mechanical anchorage consisting of **1/4-inch**-diameter, threaded stainless-steel pins set into **1/4-inch**-diameter holes drilled into backing stone and into, but not through, the partial replacement. Center and space pins between **3 and 5 inches** apart and at least **2 inches** from any edge. Insert pins at least **2 inches** into backing stone and so that pins are no closer than **3/4 inch** from exposed face of partial replacement.
- E. Apply stone-to-stone adhesive to comply with adhesive manufacturer's written instructions. Coat bonding surfaces of backing stone and partial replacement, completely filling all crevices and voids.
- F. Apply partial replacement while adhesive is still tacky and hold securely in place until adhesive has cured. Use shims, clamps, wedges, or other devices as necessary to align face of partial replacement with face of backing stone.
- G. Clean adhesive residue from exposed surfaces and patch chipped areas as specified in "Stone Patching" Article.

3.6 STONE-FRAGMENT (INCIPIENT SPALL) REPAIR.

- A. Carefully remove cracked or fallen stone fragment indicated to be repaired. Reuse only stone fragment that is in sound condition.
- B. Remove soil, loose particles, mortar, and other debris or foreign material from fragment surfaces to be bonded and from parent stone where fragment had broken off, by cleaning with stiff-fiber brush.
- C. Concealed Pinning: Before applying adhesive, prepare for concealed mechanical anchorage consisting of **1/4-inch**-diameter, threaded stainless-steel pins set into holes drilled into parent stone and into, but not through, the fragment. Center and space pins between **3 and 5 inches** apart and at least **2 inches** from any edge. Insert pins at least **2 inches** into parent stone and **2 inches** into fragment, but no closer than **3/4 inch** from exposed face of fragment.]
- D. Apply stone adhesive according to adhesive manufacturer's written instructions. Coat bonding surfaces of fragment and parent stone, completely filling all crevices and voids.
- E. Fit stone fragment onto parent stone while adhesive is still tacky and hold fragment securely in place until adhesive has cured. Use shims, clamps, wedges, or other devices as necessary to align face of fragment with face of parent stone.
- F. Clean adhesive residue from exposed surfaces and patch chipped areas as specified in "Stone Patching" Article.

3.7 PLUG REPAIR

- A. Remove cylindrical piece of damaged masonry by core-drilling perpendicular to stone surface.
- B. Prepare a replacement plug by core-drilling replacement stone. Use a drill sized to produce a core that will fit into hole drilled in damaged masonry with only minimum gap necessary for adhesive.
- C. Apply adhesive to comply with adhesive manufacturer's written instructions. Coat bonding surfaces of existing stone and plug, completely filling all crevices and voids.
- D. Apply plug while adhesive is still tacky and hold securely in place until adhesive has cured.
- E. Clean adhesive residue from exposed surfaces.

3.8 CRACK INJECTION

- A. General: Comply with cementitious crack-filler manufacturer's written instructions and as follows.

- B. Drill **1/4-inch**-diameter injection holes at top and bottom of crack adjacent to mortar joint:
- C. Clean out drill holes and cracks with compressed air and water. Remove dirt and organic matter, loose material, sealants, and failed crack repair materials.
- D. Place plastic injection ports in drilled holes and seal face of cracks between injection ports with clay or other non-staining, removable plugging material. Leave openings at upper ends of cracks for air release.
- E. Inject cementitious crack filler through ports sequentially, beginning at one end of area and working to opposite end; where possible, begin at lower end of injection area and work upward. Inject filler until it extrudes from adjacent ports. After port has been injected, plug with clay or other suitable material and begin injecting filler at adjacent port, repeating process until all ports have been injected.
- F. Clean cementitious crack filler from face of masonry before it sets by scrubbing with water.
- G. After cementitious crack filler has set, remove injection ports, plugging material, and excess filler. Patch injection holes and surface of cracks as specified in " masonry Patching" Article.

3.9 PINNING

- A. At locations indicated install Spiral type masonry repair anchors through face of masonry. Install minimum of 2 anchors per unit unless noted otherwise.
- B. Recess anchors at least **5/8 inch** from surface and fill recess with repair mortar.

3.10 REPOINTING STONE MASONRY

- A. Rake out and repoint joints to the following extent:
 - 1. All joints in areas indicated.
- B. Rake out joints as follows, according to procedures demonstrated in approved mockup:
 - 1. Saturate surface with water to soften lime-based mortar and dislodge soil.
 - 2. Cut out mortar by hand with grout saw, chisel and resilient mallet
 - 3. Remove mortar from joints to depth of 2-3 times joint width, but not less than 1/2 inch or not less than that required to expose sound, unweathered mortar.
 - 4. Remove mortar from masonry surfaces within raked-out joints to provide reveals with square backs and to expose masonry for contact with pointing mortar. Brush, vacuum, or flush joints to remove dirt and loose debris.
 - 5. Do not spall edges of masonry units or widen joints.

- C. Notify Architect of unforeseen detrimental conditions including voids in mortar joints, cracks, loose masonry units, rotted wood, rusted metal, and other deteriorated items.
- D. Pointing with Mortar:
 - 1. Rinse joint surfaces with water to remove dust and mortar particles. Time rinsing application so, at time of pointing, joint surfaces are damp but free of standing water. If rinse water dries, dampen joint surfaces before pointing.
 - 2. Apply pointing mortar first to areas where existing mortar was removed to depths greater than surrounding areas. Apply in layers not greater than 1/4 inch until a uniform depth is formed. Fully compact each layer thoroughly and allow it to become thumbprint hard before applying next layer.
 - 3. After low areas have been filled to same depth as remaining joints, point all joints by placing mortar in layers not greater than 3/8 inch. Fully compact each layer and allow to become thumbprint hard before applying next layer. Where existing masonry units have worn or rounded edges, slightly recess finished mortar surface below face of masonry to avoid widened joint faces. Take care not to spread mortar beyond joint edges onto exposed masonry surfaces or to featheredge the mortar.
 - 4. When mortar is thumbprint hard, tool joints to match original appearance of joints as demonstrated in approved mockup. Remove excess mortar from edge of joint by brushing.
 - 5. Cure mortar by maintaining in thoroughly damp condition for at least 72 consecutive hours including weekends and holidays.
 - a. Acceptable curing methods include covering with wet burlap and plastic sheeting, periodic hand misting, and periodic mist spraying using system of pipes, mist heads, and timers.
 - 6. Hairline cracking within the mortar or mortar separation at edge of a joint is unacceptable. Completely remove such mortar and repoint.
- E. Where repointing work precedes cleaning of existing masonry, allow mortar to harden at least 30 days before beginning cleaning work.

3.11 MODIFICATION OF EXISTING STONE

- A. Where indicated, modify existing stone to provide a smooth face suitable for new construction that abuts existing masonry where indicated.
- B. Saw cut straight lines around limits of modification.
- C. Chip away projecting portion of stones to provide a smooth, flat, and even surface, matching the existing dressed stone on site.

3.12 PARING EXISTING MASONRY

- A. Clean masonry with pressure washer without eroding mortar.

- B. Remove and replace existing loose stones.
- C. Rake out and tuckpoint any cracked mortar joints.
- D. Chip off small projecting stone points to minimize total thickness of parging.
- E. Fill deep joints with mortar.
- F. Parge exterior faces of existing masonry walls, where indicated, in two coats to a total minimum thickness of **3/4 inch**. Dampen wall before applying first coat, and scarify first coat to ensure full bond to subsequent coat.
- G. Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of **1/4 inch per foot and not more than 1/2" total**. Form a wash at top of parging and a cove at bottom.
- H. Damp-cure parging for at least 24 hours and protect parging until cured.

3.13 STONE REPAIR SCHEDULE

- A. For pricing assume the follow stone repairs: Actual scope of work to be determined in field and adjusted using Unit Prices.
 - 1. Partial stone replacement: allow 10 SF
 - 2. Removing and resetting stone masonry: allow 10 SF
 - 3. Patching stone masonry: allow 10 SF
 - 4. Stone crack repair: allow 100 LF
 - 5. Replacing damaged stone with new stone: allow 10 SF
 - 6. Stone-fragment (incipient spall) repair: allow 10 SF
 - 7. Raking and tuckpoint mortar joints in stone: allow 25% of total area of stone distributed evenly over entire area of stone.
 - 8. Parging of existing stone foundations: As indicated on drawings.
 - 9. Modification of existing stone for new construction: As indicated on drawings.
 - 10. Pin 20 new spiral anchors scattered across entire building.

END OF SECTION

SECTION 04 20 00

UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Mortar and grout.
3. Steel reinforcing bars.
4. Masonry-joint reinforcement.
5. Ties and anchors.
6. Miscellaneous masonry accessories.

B. Products Installed but not Furnished under this Section:

1. Cast-stone trim in unit masonry.
2. Steel lintels in unit masonry.
3. Steel shelf angles for supporting unit masonry.

1.2 DEFINITIONS

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

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
2. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315. Show elevations of reinforced walls.

C. Samples for Verification: For each type and color of the following:

1. Accessories embedded in masonry.

1.5 INFORMATIONAL SUBMITTALS

- A. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.
 - 1. Submittal is for information only. Receipt of list does not constitute approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.
- B. Material Certificates: For each type and size of the following:
 - 1. Masonry units.
 - a. Include data on material properties.
 - b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
 - 2. Cementitious materials. Include name of manufacturer, brand name, and type.
 - 3. Mortar admixtures.
 - 4. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
 - 5. Grout mixes. Include description of type and proportions of ingredients.
 - 6. Reinforcing bars.
 - 7. Joint reinforcement.
 - 8. Anchors, ties, and metal accessories.
- C. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
 - 1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
 - 2. Include test reports, according to ASTM C1019, for grout mixes required to comply with compressive strength requirement.
- D. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to TMS 602/ACI 530.1/ASCE 6.
- E. 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. Testing Agency Qualifications: Qualified third-party testing agency according to ASTM C1093 for testing indicated.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Build mockup 6 feet long by 4 feet high as shown on Drawings.

2. Protect accepted mockups from the elements with weather-resistant membrane.
3. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
 - a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
 - b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 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. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.8 FIELD CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each work day. Cover partially completed masonry when construction is not in progress.
 1. Extend cover a minimum of 24 inches (600 mm) down both sides of walls, and hold cover securely in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 2. Protect sills, ledges, and projections from mortar droppings.

3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 PERFORMANCE REQUIREMENTS

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

2.3 UNIT MASONRY, GENERAL

- A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6, except as modified by requirements in the Contract Documents.
- B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work and will be within 20 feet (6 m) vertically and horizontally of a walking surface.

- C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.

1. Where fire-resistance-rated construction is indicated, units shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

2.4 CONCRETE MASONRY UNITS

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

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Provide bullnose units for outside corners unless otherwise indicated.

- B. CMUs: ASTM C90.

1. Density Classification: Normal weight.
2. Size (Width): Manufactured to dimensions 3/8 inch (10 mm) less than nominal dimensions.
3. Exposed Faces: Provide color and texture matching the range represented by Architect sample.

2.5 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

1. Alkali content shall not be more than 0.1 percent when tested according to ASTM C114.

- B. Hydrated Lime: ASTM C207, Type S.

- C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

- D. Aggregate for Mortar: ASTM C144.

1. For joints less than 1/4 inch (6 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18 mm) sieve.

- E. Aggregate for Grout: ASTM C404.

- F. Water: Potable.

2.6 REINFORCEMENT

- A. Uncoated-Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, Grade 60 (Grade 420).

- B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells or as indicated on Drawings. Units are formed from 0.148 inch (3.77 mm) steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.
- C. Masonry-Joint Reinforcement, General: ASTM A951/A951M.
 - 1. Material: Hot-dip galvanized carbon steel.
 - 2. Wire Size for Side Rods: 0.148 inch (3.77 mm) diameter, unless noted otherwise on Drawings.
 - 3. Wire Size for Cross Rods: 0.148 inch (3.77 mm) diameter.
 - 4. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches (407 mm) o.c.
 - 5. Provide in lengths of not less than 10 feet (3 m) with prefabricated corner and tee units.
- D. Masonry-Joint Reinforcement for Single-Wythe Masonry: Ladder or truss type with single pair of side rods.

2.7 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 A82/A82M, with ASTM A153/A153M, Class B-2 coating.
 - 2. Steel Sheet, Galvanized after Fabrication: ASTM A1008/A1008M, Commercial Steel, with ASTM A153/A153M, Class B coating.
 - 3. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- 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 (6.35 mm) diameter, hot-dip galvanized steel wire.
 - 2. Tie Section: Triangular-shaped wire tie made from 0.187 inch (4.76 mm) diameter, hot-dip galvanized steel.
- C. Partition Top Anchors: 0.105-inch- (2.66-mm-) thick metal plate with a 3/8-inch- (9.5-mm-) diameter metal rod 6 inches (152 mm) long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.

2.8 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene or urethane.
- B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

- C. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Mortar Break; Advanced Building Products, Inc.
- b. CavClear Masonry Mat; CavClear.
- c. Mortar Net; Mortar Net USA, Ltd.
- d. Mortar Stop; Polytite Manufacturing Corp.

2.9 MASONRY CLEANERS

- A. Proprietary Acidic Cleaner: Manufacturer 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. Products: Subject to compliance with requirements, provide one of the following:

- a. Diedrich Technologies, Inc.; a Hohmann & Barnard company.
- 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.

- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

- C. Mortar for Unit Masonry: Comply with ASTM C270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated.

1. For masonry below grade or in contact with earth, use Type M.
2. For reinforced masonry, use Type S.
3. For exterior, above-grade, load-bearing and nonload-bearing walls and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type N.
4. For interior nonload-bearing partitions, Type O may be used instead of Type N.

- D. Grout for Unit Masonry: Comply with ASTM C476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C476, Table 1.
3. Provide grout with a slump of 8 to 11 inches (200 to 280 mm) as measured according to ASTM C143/C143M.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION, GENERAL

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

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 (12 mm) or minus 1/4 inch (6 mm).
 - 2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch (12 mm).
 - 3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch (6 mm) in a story height or 1/2 inch (12 mm) 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 (6 mm in 3 m), or 1/2 inch (12 mm) maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch (12 mm) 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 (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch (12 mm) maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2 inch (12 mm) maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch (1.5 mm) 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 (3 mm), with a maximum thickness limited to 1/2 inch (12 mm).
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch (3 mm).
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch (9 mm) or minus 1/4 inch (6 mm).
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm). Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch (3 mm).
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch (1.5 mm) 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 indicated on Drawings; do not use units with less-than-nominal 4 inch (100 mm) 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 2 inches (50 mm). Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal 4 inch (100 mm) horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

- E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
- G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.
- H. Fill cores in hollow CMUs with grout 24 inches (600 mm) under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.
- I. Build nonload-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.
 - 1. Install compressible filler in joint between top of partition and underside of structure above.
 - 2. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 07 84 43 "Joint Firestopping."

3.5 MORTAR BEDDING AND JOINTING

- A. Lay CMUs as follows:
 - 1. Bed face shells in mortar and make head joints of depth equal to bed joints.
 - 2. Bed webs in mortar in all courses of piers, columns, and pilasters.
 - 3. Bed webs in mortar in grouted masonry, including starting course on footings.
 - 4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
 - 5. Fully bed units and fill cells with mortar at anchors and ties as needed to fully embed anchors and ties in mortar.
- B. 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.
- D. Cut joints flush where indicated to receive cavity wall insulation 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 (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (150 mm).
 - 1. Space reinforcement not more than 16 inches (406 mm) o.c.
 - 2. Space reinforcement not more than 8 inches (203 mm) o.c. in foundation walls and parapet walls. Refer to Drawings for additional requirements.
 - 3. Provide reinforcement not more than 8 inches (203 mm) above and below wall openings and extending 12 inches (305 mm) 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. 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 (25 mm) 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 (610 mm) o.c. vertically and 36 inches (915 mm) 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 as follows:
 - 1. Install preformed control-joint gaskets designed to fit standard sash block.

3.9 LINTELS

- A. Install steel lintels where indicated.
- B. Provide minimum bearing of 8 inches (200 mm) at each jamb unless otherwise indicated.

3.10 REINFORCED UNIT MASONRY

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction. Masonry walls designed for attachment to completed building as indicated on the Drawings.
 - 1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
 - 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and that of other loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6.

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

3.11 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor expense.
- B. Testing Prior to Construction: One set of tests.
- C. Testing Frequency: One set of tests for each 5000 sq. ft. (464 sq. m) of wall area or portion thereof.
- D. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C140 for compressive strength.
- E. Mortar Test (Property Specification): For each mix provided, according to ASTM C780.
- F. Grout Test (Compressive Strength): For each mix provided, according to ASTM C1019.

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 approval of sample cleaning before proceeding with cleaning of masonry.
 - 3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
 - 4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.

5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
6. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.

3.13 MASONRY WASTE DISPOSAL

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

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SECTION 05 01 70
METAL RESTORATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes historic treatment of exposed exterior metal to remain on the existing building including but not limited to:
 - 1. Removing paint.
 - 2. Removing corrosion.
 - 3. Painting metal.

1.2 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified historic treatment specialist to perform preconstruction paint removal testing on cast iron.
 - 1. Notify Architect seven days in advance of the dates and times when testing will be performed.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include recommendations for application and use. Include test data substantiating that products comply with requirements.
- A. Paint Samples: For each color required.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For historic treatment specialist
- B. Historic Treatment Program: Submit before work begins.
- C. Preconstruction Test Reports: For historic treatment of decorative metal.

1.5 QUALITY ASSURANCE

- A. Historic Treatment Specialist Qualifications: A qualified historic decorative metal specialist.

- B. Paint-Remover Manufacturer Qualifications: A firm regularly engaged in producing paint removers that have been used for similar historic decorative metal applications with successful results, and with factory-trained representatives who are available for consultation and Project-site inspection and assistance at no additional cost.
- C. Historic Treatment Program: Prepare a written plan for historic treatment of decorative metal, including each phase or process, protection of surrounding materials during operations, and control of runoff during cleaning, paint removal, and other processes. Describe in detail materials, methods, and equipment to be used for each phase of work. Show compliance with indicated methods and procedures related to historic treatment of decorative metal specified in this and other Sections.
- D. Preinstallation Conference: Conduct conference at Project site
 - 1. Review methods and procedures related to historic treatment of decorative metal including, but not limited to, the following:
 - a. Construction Schedule: Verify availability of materials, personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Materials, material application, sequencing, tolerances, and required clearances.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Pack, deliver, and store decorative metal items in suitable packs, heavy-duty cartons, or wooden crates; surround with sufficient packing material to ensure that products will not be deformed, cracked, or otherwise damaged.
- B. Store decorative metal inside a well-ventilated area, away from uncured concrete and masonry and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.
- C. Protect strippable protective covering on decorative metal from exposure to sunlight and high humidity, except to the extent necessary for the period of decorative metal installation.

1.7 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with historic treatment of decorative metal only when existing and forecasted weather conditions are within the environmental limits set by each manufacturer's written instructions and specified requirements.
- B. Concealed and undocumented historic items, relics, and similar objects encountered during historic treatment remain Owner's property. Carefully dismantle and salvage each item or object.

- C. Lead-Containing Paint: Lead-containing paint is assumed to be present on existing metal.
 - 1. Comply with all applicable regulations for removal and disposal of lead-containing paint
- D. Perform work in the following sequence (address alternates to this sequence in the Treatment Plan):
 - 1. Remove paint.
 - 2. Remove or treat corrosion.
 - 3. Paint metal

PART 2 - PRODUCTS

- 2.1 General: Base selection of materials and methods of use on the following, subject to approval of a mockup:
 - A. Previous effectiveness in performing the work involved.
 - B. Little possibility of damaging exposed surfaces.
 - C. Consistency of each application.
 - D. Uniformity of the resulting overall appearance.
 - E. Do not use products or tools that could do the following:
 - 1. Remove, alter, or in any way harm the present condition or future preservation of surfaces, including surrounding surfaces not in contract.
 - 2. Leave an unintended residue on surfaces.
- 2.2 CLEANING MATERIALS
 - A. Water: Potable.
 - B. Abrasive Materials:
 - 1. Abrasives for Ferrous Metal Cleaning: plastic abrasive pads Aluminum oxide paper, emery paper, fine steel wool, steel scrapers, and steel-wire brushes.
 - C. Rust Remover: Manufacturer's standard phosphoric acid-based gel formulation, for removing corrosion from iron and steel.

2.3 PAINT REMOVERS

- A. Covered or Skin-Forming Alkaline Paint Remover: Manufacturer's standard covered or skin-forming alkaline formulation for removing paint from metal.
- B. Low-Odor, Solvent-Type Paint Remover: Manufacturer's standard low-odor, water-rinsable solvent-type gel formulation, containing no methanol or methylene chloride, for removing paint from metals.
- C. Liquid Strippable Masking Agent: Manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, and polished stone surfaces from damaging effects of acidic and alkaline cleaners.
 - 1. Products: Subject to compliance with requirements, provide the following provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ABR Products, Inc.; Rubber Mask.
 - b. Price Research, Ltd.; Price Mask.
 - c. PROSOCO, Inc.; Sure Klean Strippable Masking.
- D. Masking Tape: Nonstaining, nonabsorbent material; compatible with chemical solutions being used and substrate surfaces; and that will easily come off entirely, including adhesive.

2.4 PAINT PRODUCTS

- 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. MPI Standards: where indicated provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."
- C. Colors: as selected by Architect from manufacturer's full range.
- D. Metal Primer for Cast Iron: Modified Aromatic Polyurethane Primer
 - 1. Basis of Design Product: Tnemec Series One Omnithane.
- E. Intermediate and top Coat for cast Iron: Aliphatic Acrylic Polyurethane
 - 1. Basis of Design Product: Tnemec Series 1075 Endurashield II.

PART 3 - EXECUTION

3.1 PREPARATION

- A. General: Protect persons, motor vehicles, building site, plants, surrounding surfaces of building being restored, and surrounding buildings from harm resulting from historic treatment of decorative metal.
 - 1. Erect temporary protective covers over walkways and at points of pedestrian and vehicular entrance and exit that must remain in service during course of historic treatment Work.
- B. Comply with chemical-product manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent chemical solutions from coming into contact with people, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.
 - 1. Cover adjacent surfaces with materials that are proven to resist chemical solutions being used unless the solutions will not damage adjacent surfaces. Apply masking agents to comply with manufacturer's written instructions. Do not apply liquid strippable masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.
 - 2. Keep wall wet below area being treated to prevent streaking from runoff.
 - 3. Do not apply chemical solutions during winds of sufficient force to spread them to unprotected surfaces.
 - 4. Neutralize and collect alkaline and acid wastes for disposal off Owner's property.
 - 5. Dispose of runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

3.2 CLEANING, PAINT REMOVAL, RUST REMOVAL

- A. General: Use only those methods indicated for each type of decorative metal. Apply materials to all surfaces, corners, contours, and interstices, to provide a uniform final appearance without streaks. After work is complete, remove protection no longer required. Remove tape and adhesive marks.
 - 1. Brushes: Use wire brushes of same metal composition as metal being treated. Use brushes that are resistant to chemicals being used. Do not use plastic-bristle brushes if natural-fiber brushes will resist chemicals being used.
 - 2. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at spray tip. Adjust pressure and volume to ensure that spray methods do not damage surfaces.
 - a. Equip units with pressure gages.

- b. Unless otherwise indicated, hold spray tip at least 6 inches (150 mm) from surface and apply material in horizontal, back-and-forth sweeping motion, overlapping previous strokes to produce uniform coverage.
- c. For chemical spray application, use low-pressure tank or chemical pump suitable for chemical indicated, equipped with cone-shaped spray tip.
- d. For water-spray application, use fan-shaped spray tip that disperses water at an angle of 25 to 50 degrees.

B. Chemical Rust Removal:

- 1. Remove loose rust scale with approved abrasives for ferrous metal cleaning.
- 2. Apply rust remover with brushes or as recommended by manufacturer.
- 3. Allow rust remover to remain on surface for period recommended by manufacturer or as determined by preconstruction testing. Do not allow extended dwell time.
- 4. Wipe off residue with mineral spirits and either steel wool or soft rags, or clean with method recommended by manufacturer to remove residue.
- 5. Dry immediately with clean, soft cloths. Follow direction of grain in metal.
- 6. Prime immediately to prevent rust. Do not touch cleaned metal surface until primed.

C. Chemical paint/corrosion removers:

- 1. Apply chemical paint remover to surfaces to comply with manufacturer's written instructions; use brush application methods. Do not allow chemicals to remain on surface for periods longer than those indicated or recommended by manufacturer.
- 2. Do not apply chemical removers to same surfaces more than twice.
- 3. Neutralize chemical residue, and rinse where applicable, by working upward from bottom to top of each treated area at each stage or scaffold setting.
- 4. Comply with manufacturer's written instructions for protecting building surfaces against damage from exposure to their products.
- 5. Neutralize and collect alkaline and acid wastes for disposal off Owner's property.
- 6. Dispose of runoff from cleaning operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

3.3 FIELD QUALITY CONTROL

- A. Inspectors: Owner will engage qualified independent inspectors to perform inspections and prepare test reports. Allow inspectors use of lift devices and scaffolding, as needed, to perform inspections.
- B. Notify inspectors in advance of times when lift devices and scaffolding will be relocated. Do not relocate lift devices and scaffolding until inspectors have had reasonable opportunity to inspect work areas at locations of lift devices or scaffolding.

516 N. KING ST, WILMINGTON DE 19801
NOVEMBER 22, 2024

CUSTOMS HOUSE RENOVATION AND ADDITION
#MJ0217000003-BP4

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SECTION 05 12 00
STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Structural steel.
2. Shear stud connectors.
3. Shrinkage-resistant grout.
4. Architecturally exposed structural steel (AESS).
 - a. All exposed structural and miscellaneous steel associated with the monumental stair shall be AESS 3.

B. Related Requirements:

1. Section 053100 "Steel Decking" for field installation of shear stud connectors through deck.
2. Section 055000 "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame and other steel items not defined as structural steel.
3. Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" and Section 099600 "High-Performance Coatings" for painting requirements.
4. Section 055100 "Metal Stairs"

1.3 DEFINITIONS

- A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in ANSI/AISC 303.
- B. Category AESS 3: Structural steel that is categorized by ANSI/AISC 303, Section 10, as AESS 3 and is designated as AESS 3 or Category AESS 3 in the Contract Documents.

1.4 COORDINATION

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

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

1.5 PREINSTALLATION MEETINGS

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

1.6 ACTION SUBMITTALS

- A. Product Data:

1. Structural-steel materials.
2. High-strength, bolt-nut-washer assemblies.
3. Shear stud connectors.
4. Anchor rods.
5. Threaded rods.
6. Forged-steel hardware.
7. Slide bearings.
8. Prefabricated building columns.
9. Shop primer.
10. Galvanized-steel primer.
11. Etching cleaner.
12. Galvanized repair paint.
13. Shrinkage-resistant grout.

- B. Sustainable Design Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

- C. Shop Drawings of Structural Steel: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment Drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
5. Identify members not to be shop primed.

- D. Shop Drawings of AESS Steel: Show fabrication of AESS components. Shop Drawings for structural steel may be used for AESS.
1. Identify AESS category for each steel member and connection, including transitions between AESS categories and between AESS and non-AESS.
 2. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 3. Include embedment Drawings.
 4. Indicate orientation of mill marks and HSS seams.
 5. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain. Indicate grinding, finish, and profile of welds.
 6. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections. Indicate orientation and location of bolt heads.
 7. Indicate exposed surfaces and edges and surface preparation being used.
 8. Indicate special tolerances and erection requirements.
 9. Indicate weep holes for HSS and vent holes for galvanized HSS.
 10. Indicate surface preparation, primer, and coating requirements, including systems specified in other Sections.
- E. Delegated-Design Submittal: For structural-steel connections indicated on Drawings to comply with design loads, include analysis data signed and sealed by the qualified professional engineer responsible for their preparation. All shear and moment connections per loads indicated on drawings.

1.7 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- C. Mill test reports for structural-steel materials, including chemical and physical properties.
- D. Product Test Reports: For the following:
1. Bolts, nuts, and washers, including mechanical properties and chemical analysis.
 2. Direct-tension indicators.
 3. Tension-control, high-strength, bolt-nut-washer assemblies.
 4. Shear stud connectors.
- E. Survey of existing conditions and anchor bolts.
- F. Source quality-control reports.

1.8 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

1.9 DELIVERY, STORAGE, AND HANDLING

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with applicable provisions of the following specifications and documents:
 - 1. ANSI/AISC 303.
 - 2. RCSC's "Specification for Structural Joints Using High-Strength Bolts."
- B. Connection Design Information:
 - 1. Option 3 and 3B: Design connections and final configuration of member reinforcement at connections in accordance with ANSI/AISC 303 by fabricator's qualified professional engineer.
 - a. Use Allowable Stress Design; data are given at service-load level.
- C. Moment Connections: Type PR, partially and Type FR, fully restrained. Reference drawing details.

- D. Construction: Moment frame.

2.2 STRUCTURAL-STEEL MATERIALS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. W-Shapes: ASTM A992/A992M Grade 50 (Grade 345)
- C. Channels, Angles: ASTM A36/A36M.
- D. Plate and Bar: ASTM A36/A36M.
- E. Corrosion-Resisting (Weathering) Structural-Steel Shapes, Plates, and Bars: ASTM A588/A588M, 50 ksi (345 MPa).
- F. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade B structural tubing.
- G. Steel Pipe: ASTM A53/A53M, Type E or Type S, Grade B.
1. Finish: Black except where indicated to be galvanized.
- H. Steel Castings: ASTM A216/A216M, Grade WCB, with supplementary requirement S11.
- I. Steel Forgings: ASTM A668/A668M.
- J. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS AND CONNECTORS

- A. High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325 (Grade A325M), Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH (ASTM A563M, Class 10S), heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.
1. Direct-Tension Indicators: ASTM F959/F959M, Type 325-1 (Type 8.8-1), compressible-washer type with plain finish.
- B. Zinc-Coated High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325 (Grade A325M), Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH (ASTM A563M, Class 10S), heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.
1. Finish: Hot-dip zinc coating.

- C. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 1, heavy-hex head assemblies, consisting of steel structural bolts with splined ends; ASTM A563, Grade DH (ASTM A563M, Class 10S), heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

1. Finish: Plain

- D. Shear Stud Connectors: ASTM A108, AISI C-1015 through C-1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

2.4 RODS

- A. Unheaded Anchor Rods: ASTM F1554, Grade 36.

1. Configuration: Reference drawings.
2. Nuts: ASTM A563 (ASTM A563M) heavy-hex carbon steel.
3. Plate Washers: ASTM A36/A36M carbon steel.
4. Washers: ASTM F436 (ASTM F436M), Type 1, hardened carbon steel.
5. Finish: Plain or Hot-dip zinc coating, ASTM A153/A153M, Class C. See drawings for galvanizing/galvanize at exterior exposure.

- B. Headed Anchor Rods: ASTM F1554, Grade 36.

1. Nuts: ASTM A563 (ASTM A563M) heavy-hex carbon steel.
2. Plate Washers: ASTM A36/A36M carbon steel.
3. Washers: ASTM F436 (ASTM F436M), Type 1, hardened carbon steel.
4. Finish: Plain or Hot-dip zinc coating, ASTM A153/A153M, Class C. See drawings for galvanizing/galvanize at exterior exposure.

- C. Threaded Rods: ASTM A36/A36M.

1. Nuts: ASTM A563 (ASTM A563M) heavy-hex carbon steel.
2. Washers: ASTM F436 (ASTM F436M), Type 1, hardened, ASTM A36/A36M carbon steel.
3. Finish: Plain or Hot-dip zinc coating, ASTM A153/A153M, Class C. See drawings for hot dipped galvanizing/galvanize at exterior exposure.

2.5 FORGED-STEEL STRUCTURAL HARDWARE

- A. Clevises and Turnbuckles: Made from cold-finished carbon-steel bars, ASTM A108, AISI C-1035.
- B. Eye Bolts and Nuts: Made from cold-finished carbon-steel bars, ASTM A108, AISI C-1030.

- C. Sleeve Nuts: Made from cold-finished carbon-steel bars, ASTM A108, AISI C-1018.

2.6 PRIMER

- A. Steel Primer: 09 96 10 Exterior High Performance Coatings.

1. Comply with Section 099113 "Exterior Painting" and Section 099123 "Interior Painting." Section 099600 "High-Performance Coatings." Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."
2. SSPC-Paint 23, latex primer.
3. Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

- B. Galvanized-Steel Primer: MPI#26, MPI#80, or MPI#134.

1. Etching Cleaner: MPI#25, for galvanized steel.
2. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20, ASTM A780/A780M.

2.7 SHRINKAGE-RESISTANT GROUT

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

2.8 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.
1. Camber structural-steel members where indicated.
 2. Fabricate beams with rolling camber up.
 3. Identify high-strength structural steel in accordance with ASTM A6/A6M and maintain markings until structural-steel framing has been erected.
 4. Mark and match-mark materials for field assembly.
 5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.
- C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted in accordance with SSPC-SP 1, SSPC-SP 2 or SSPC-SP 3.
- F. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using automatic end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.
- G. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural-steel frame. Straighten as required to provide uniform, square, and true members in completed wall framing. Build up welded framing, weld exposed joints continuously, and grind smooth.
- H. Welded-Steel Door Frames: Build up welded-steel door frames attached to structural-steel frame. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk machine screws, uniformly spaced not more than 10 inches (250 mm) o.c. unless otherwise indicated on Drawings.
- I. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.
 1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
 2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.9 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.
 1. Joint Type: Snug tightened and slip critical as indicated on drawings.
- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

2.10 FABRICATION OF AESS STEEL

- A. Shop fabricate and assemble AESS to the maximum extent possible. Locate field joints at concealed locations if possible. Detail assemblies to minimize handling and to expedite erection.

1. Use special care handling and fabricating AESS before and after shop painting to minimize damage to shop finish.

B. Category AESS 3:

1. Comply with overall profile dimensions of AWS D1.1/D1.1M for welded built-up members. Keep appearance and quality of welds consistent. Maintain true alignment of members without warp exceeding specified tolerances.
2. Prepare surfaces according to Part 2 "Shop Priming" Article and SSPC-SP 6 (WAB)/NACE WAB-3.
3. Grind sheared, punched, and flame-cut edges to remove burrs and provide smooth surfaces and eased edges.
4. Make intermittent welds appear continuous, using filler or additional welding.
5. Seal weld open ends of hollow structural sections with 3/8-inch (9.5-mm) closure plates.
6. Limit butt and plug weld projections to 1/16 inch (1.6 mm).
7. Install bolt heads on the same side of each connection and maintain orientation consistently from one connection to another.
8. Remove weld spatter, slivers, and similar surface discontinuities.
9. Remove blemishes and surface irregularities resulting from temporary braces or fixtures by filling or grinding, before cleaning, treating, and shop priming.
10. Grind tack welds smooth unless incorporated into final welds.
11. Remove backing and runoff tabs, and grind welds smooth.
12. Limit as-fabricated straightness tolerance to one-half that permitted for structural-steel materials in ANSI/AISC 303.
13. Limit as-fabricated curved structural steel tolerance to that permitted for structural-steel materials in ANSI/AISC 303.
14. Limit as-fabricated straightness tolerance of welded built-up members to one-half that permitted by AWS D1.1/D1.1M.
15. Conceal fabrication and erection markings from view in the completed structure.
16. Make welds uniform and smooth.
17. Cut out mill marks from mill material or hide these markings from view in the completed structure. Where neither method is possible, remove mill marks by grinding and filling surfaces as approved by Architect.
18. Grind butt and plug welds smooth or fill, removing weld splatter exposed to view.
19. Orient HSS seams as indicated or away from view.
20. Align and match abutting member cross sections.

21. At visible open joints of copes, miters, and cuts, maintain uniform clear gaps of 1/8 inch (3.2 mm). At closed joints, maintain uniform contact within 1/16 inch (1.6 mm).
22. Fabricate with exposed surfaces smooth, square, and of surface quality approved by Architect.

2.11 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel in accordance with ASTM A123/A123M.
 1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.
 2. Galvanize lintels, shelf angles, and all other elements indicated on the drawings.

2.12 SHOP PRIMING

- A. Shop prime steel surfaces, except the following:
 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
 2. Surfaces to be field welded.
 3. Surfaces of high-strength bolted, slip-critical connections.
 4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
 5. Galvanized surfaces unless indicated to be painted.
 6. Corrosion-resisting (weathering) steel surfaces.
- B. Surface Preparation of Steel: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces in accordance with the following specifications and standards:
 1. SSPC-SP 2.
 2. SSPC-SP 3.
 3. SSPC-SP 7 (WAB)/NACE WAB-4.
 4. SSPC-SP 14 (WAB)/NACE WAB-8.
 5. SSPC-SP 11.
 6. SSPC-SP 6 (WAB)/NACE WAB-3.
 7. SSPC-SP 10 (WAB)/NACE WAB-2.
 8. SSPC-SP 5 (WAB)/NACE WAB-1.
 9. SSPC-SP 8.
- C. Surface Preparation of Galvanized Steel: Prepare galvanized-steel surfaces for shop priming by thoroughly cleaning steel of grease, dirt, oil, flux, and other foreign matter, and treating with etching cleaner or in accordance with SSPC-SP 16.

- D. Priming: Immediately after surface preparation, apply primer in accordance with manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.
- E. Reference painting specification for primer and finish coat of AESS steel.

2.13 SOURCE QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform shop tests and inspections.
1. Allow testing agency access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
 2. Bolted Connections: Inspect and test shop-bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
 3. Welded Connections: Visually inspect shop-welded connections in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
 - a. Liquid Penetrant Inspection: ASTM E165/E165M.
 - b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
 - c. Ultrasonic Inspection: ASTM E164.
 - d. Radiographic Inspection: ASTM E94/E94M.
 4. In addition to visual inspection, test and inspect shop-welded shear stud connectors in accordance with requirements in AWS D1.1/D1.1M for stud welding and as follows:
 - a. Perform bend tests if visual inspections reveal either a less-than- continuous 360-degree flash or welding repairs to any shear stud connector.
 - b. Conduct tests in accordance with requirements in AWS D1.1/D1.1M on additional shear stud connectors if weld fracture occurs on shear stud connectors already tested.
 5. Prepare test and inspection reports.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Verify, with steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
 - 1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated on Drawings.

3.3 ERECTION OF STRUCTURAL STEEL

- A. Set structural steel accurately in locations and to elevations indicated and in accordance with ANSI/AISC 303 and ANSI/AISC 360.
- B. Baseplates Bearing Plates and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials and roughen surfaces prior to setting plates. Clean bottom surface of plates.
 - 1. Set plates for structural members on wedges, shims, or setting nuts as required.
 - 2. Weld plate washers to top of baseplate.
 - 3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
 - 4. Promptly pack shrinkage-resistant grout solidly between bearing surfaces and plates, so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for grouting.
- C. Maintain erection tolerances of structural steel within ANSI/AISC 303.

- D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure. Slope roof framing members to slopes indicated on Drawings.
 - 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.
- F. Do not use thermal cutting during erection.
- G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 ERECTIONS OF AECS

- A. Take special care during erection to avoid marking or distorting the AECS and to minimize damage to shop painting. Set AECS accurately in locations and to elevations indicated and according to ANSI/AISC 303 and ANSI/AISC 360.
 - 1. Remove welded tabs that were used for attaching temporary bracing and safety cabling and that are exposed to view in the completed Work. Take care to avoid any blemishes, holes, or unsightly surfaces resulting from the use or removal of temporary elements.
 - 2. Grind tack welds smooth.
 - 3. Remove backing and runoff tabs, and grind welds smooth.
 - 4. Orient bolt heads on the same side of each connection and maintain orientation consistently from one connection to another.
 - 5. Remove erection bolts in Category AECS 3 AECS, fill holes with weld metal or filler, and grind or sand smooth to achieve surface quality approved by Architect.
 - 6. Fill weld access holes in Category AECS 3 AECS with weld metal or filler and grind, or sand smooth to achieve surface quality as approved by Architect.
 - 7. Conceal fabrication and erection markings from view in the completed structure.
- B. In addition to ANSI/AISC 303, Section 10 requirements, comply with the following.
 - 1. Erection of Category AECS 3:
 - a. Erect AECS to the standard frame tolerances specified in ANSI/AISC 303 for non-AECS.
 - b. Comply with AWS D1.1/D1.1M. Keep appearance and quality of welds consistent. Maintain true alignment of members without warp exceeding specified tolerances.
 - c. Remove weld spatter, slivers, and similar surface discontinuities.

- d. Grind off butt and plug weld projections larger than 1/16 inch (1.6 mm).
- e. Continuous welds are to be of uniform size and profile.
- f. Ream holes that must be enlarged. Use of drift pins or burning is not permitted. Replace misaligned connection plates where holes cannot be aligned with acceptable appearance.
- g. Splice members only where indicated on Drawings.
- h. No torch cutting or field fabrication is permitted.
- i. Weld profiles, quality, and finish are as approved by Architect.
- j. Make joint welds, including tack welds, appear continuous by filling intermittent welds.

3.5 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt and joint type specified.
 - 1. Joint Type: Snug tightened and Slip critical where indicated on drawings.
- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
 - 1. Comply with ANSI/AISC 303 and ANSI/AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
 - 2. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material

3.6 REPAIR

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing, and repair galvanizing to comply with ASTM A780/A780M.
- B. Touchup Painting:
 - 1. Immediately after erection, clean exposed areas where primer is damaged or missing, and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC- SP 3 power-tool cleaning.
 - 2. Cleaning and touchup painting are specified in 09 96 10 Exterior High Performance Coatings. Comply with Section 099113 "Exterior Painting" and Section 099123 "Interior Painting." Section 099600 "High-Performance Coatings." Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."
 - 3. SSPC-Paint 23, latex primer.

4. Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

3.7 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform the following special inspections:
 1. Verify structural-steel materials and inspect steel frame joint details.
 2. Verify weld materials and inspect welds.
 3. Verify connection materials and inspect high-strength bolted connections.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
 1. Bolted Connections: Inspect and test bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
 2. Welded Connections: Visually inspect field welds in accordance with AWS D1.1/D1.1M.
 - a. In addition to visual inspection, test and inspect field welds in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
 - 1) Liquid Penetrant Inspection: ASTM E165/E165M.
 - 2) Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
 - 3) Ultrasonic Inspection: ASTM E164.
 - 4) Radiographic Inspection: ASTM E94/E94M.

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SECTION 05 40 00
COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior non-load-bearing wall framing and soffit framing.
2. Exterior bearing wall framing.
3. Miscellaneous exterior non-load-bearing framing not specified elsewhere.
4. Delegated Design Engineering of CFMF.

B. Related Requirements:

1. Section 01 83 16 "Exterior Enclosure General Requirements" for additional requirements related to the building enclosure including but not limited to:
 - a. Performance and design requirements for the exterior building enclosure.
 - b. Coordination of Work required to complete the Exterior Enclosure.
 - c. Pre-Construction Mockup
 - d. Quality Assurance and Control procedures required for the work of the Exterior Enclosure.
 - e. Independent inspection and testing required to verify performance of the work of this section.
2. Each technical section for cladding installed over the metal framing.
3. Divisions 06 and 07 sections for zee-girt cladding sub support systems attached to CFMF.

1.2 DEFINITIONS

- A. Refer to Division 01 Section 01 83 16 "Exterior Enclosure General Requirements" for definitions related to Exterior Enclosure.
- B. Heavy Gage: Where CFMF is indicated on drawings as "HEAVY" or "HEAVY GAGE" provide Minimum Base-Metal Thickness of 0.0966 inch unless thicker material is required to support loading as determined by delegated design.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate work of this section with adjacent components of the exterior enclosure. Participate in coordination required in Division 01 Section 01 83 16 "Exterior Enclosure General Requirements".
 - 1. Coordinate the layout of clips, furring, brackets, anchors and other devices to support cladding that are attached to the CFMF.
- B. Preinstallation Meetings:
 - 1. Preinstallation Conference: Conduct conference at Project site.
 - 2. In addition to requirements specified in Division 01 Section 01 31 00 "Project Management and Coordination," include the following:
- C. Exterior Enclosure Coordination Workshops: Participate in workshops indicated in Division 01 Section 01 43 25 "Exterior Enclosure Performance Requirements."
- D. Sequencing / Scheduling: Comply with requirements specified in Division 1 Section 01 43 25 "Exterior Enclosure Performance Requirements".

1.4 SUBMITTALS REQUIREMENTS

- A. Submit per the requirements of Section 01 33 00 Submittal Procedures and as indicated herein.
- B. CM shall coordinate submittals as indicated in 01 83 16 Paragraph 1.3-C and as otherwise indicated.
- C. Submit all of the following in a single complete package. Partial submittal packages shall be rejected without action.
 - 1. Product data
 - 2. Shop Drawings
 - 3. Coordination Certificate
 - 4. Material Certificates
 - 5. Delegated Design Submittals
 - 6. Sustainability submittals

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of cold-formed steel framing product and accessory.
- B. Shop Drawings:
 - 1. Provide Shop Drawings prepared by cold-formed metal framing manufacturer.

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2. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
 3. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.
 4. Include elevations of all surfaces with CFMF and include layout of all control joints required for sheathing and cladding.
 5. Include sufficient information for overlying and adjacent construction for coordination.
 6. Indicate type, size and spacing of every anchor and fastener. No anchors or fasteners under the scope of this section may be indicated as "by others" or somehow otherwise excluded from shop drawings.
 7. Shop Drawings shall be signed and sealed by the Delegated Design Engineer.
- C. Coordination Certification: Provide a certification letter from the installer of each cladding material, including sheathing, installed over the metal framing certifying that they have reviewed the shop drawings and the delegated design calculations and that the metal framing is coordinated with their work and suitable for the support of their work.
1. The CFMF shop drawings will not be reviewed without the Coordination Certificate.
- D. Delegated-Design Submittal: For cold-formed steel framing, accessories and anchors.
1. Calculations shall include cross-referencing to the shop drawings by detail number to identify the individual component being analyzed.
 2. Calculations shall be sufficient to document each condition and compliance with indicated criteria and coordination.
 3. CFMF shop drawings will not be reviewed without the Delegated Design Submittal.
- E. Sustainability Submittals:
1. Recycled Content

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Welding certificates.
- C. Product Certificates: Code Compliance certificates for studs and tracks
- D. Product Test Reports: For each listed product, for tests performed by manufacturer and witnessed by a qualified testing agency.

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1. Steel sheet.
2. Expansion anchors.
3. Power-actuated anchors.
4. Mechanical fasteners.
5. Vertical deflection clips.
6. Horizontal drift deflection clips
7. Miscellaneous structural clips and accessories.

E. Evaluation Reports: For cold-formed steel framing.

1. Products to be certified under an independent third-party inspection program administered by an agency accredited by IAS to ICC-ES AC98 IAS Accreditation Criteria for Inspection Agencies.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Member in good standing of the Steel Framing Industry Association (SFIA).

1. Products to be certified under an independent third-party inspection program administered by an agency accredited by IAS to ICC-ES AC98 IAS Accreditation Criteria for Inspection Agencies.

B. Installer Qualifications: Company who is trained and experienced to install metal framing required for this Project.

1. Certification: Contractor's shall be recognized in the Steel Framing Industry Association's (SFIA) "Contractor Certification Program
2. Experience: Minimum five (5) years installing metal framing similar to that required for this Project.
3. Completed three (3) projects of scope, schedule and complexity similar to this Project using systems similar to those required for this Project within last two (2) years as acceptable to Architect.
4. Adequately trained for type of installation required for this Project.

C. Delegated Design Engineer: Professional Engineer, licensed in State of Delaware and having a minimum of five (5) years documented experience engineering metal framing similar to that required for this Project.

1. The delegated design engineer may not exclude the requirements for coordination with adjacent and overlying work as described herein.

D. Provide certification of code compliance with the "Code Compliance Certification Program" implemented by the Steel Framing Industry Association (SFIA).

E. Product Tests: Mill certificates or data from a qualified independent testing agency or in-house testing with calibrated test equipment, indicating steel sheet complies with

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requirements, including base-steel thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

F. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

G. Comply with the following AISI specifications and standards: *{Note to specifier Must comply with at least one}*

1. AISI S100 "North American Specification for the Design of Cold-Formed Steel Structural Members."
2. AISI S240 "North American Standard for Cold-Formed Steel Structural Framing".

H. Mockup: Provide CFMF for mockup indicated in Section 01 83 16 "Exterior Enclosure General Requirements". CFMF for mockup shall include framing, bracing, supports and other CFMF necessary to brace and support the mockup.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling, as required in AISI's "Code of Standard Practice."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Recycled Content of Cold Formed Metal Framing: Provide post-consumer recycled content plus one-half pre-consumer (post-industrial) recycled content. Provide documentation indicating recycled content.
- B. Regional material for Cold Formed Metal Framing: When available, provide material sourced (extracted, manufactured, and purchased) within 100 miles of the Project Site. Provide documentation indicating distance from project site.
- C. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design cold-formed steel framing including attachments and anchorage to structure.
1. Include design of strapping, bracing, blocking or other similar features that provide support at change of sheathing or support for other elements attached to the work.

2. Include CFMF for mockup. Include framing, bracing, supports and other CFMF necessary to brace and support the mockup.
- D. Comply with performance criteria indicated in Section 01 83 16 "Exterior Enclosure General Requirements" and additional criteria indicated herein.
- E. Comply with recommendations of sheathing manufacturer.
- F. Extent of delegated design includes every item of CFMF, every anchor and fastener within CFMF, every clip or accessory necessary to reinforce CFMF or to attach CFMF, miscellaneous steel items that may be necessary to support or anchor CFMF, every anchor or fastener to attach CFMF to adjacent construction and every other accessory or framing as required to support exterior assemblies starting from the existing or new precast concrete, slab edges, structural steel, metal decking or other similar elements shown on the structural drawings. If such elements are not sized and engineered on the structural drawings, then it is the responsibility of the delegated design engineer to provide the final engineering.
- G. Support of Veneers, Cladding, Fenestration, Doors, Louvers: Coordinate the layout of CFMF and provide additional or thicker CFMF members to provide support for the overlying veneers and cladding, and any element of the enclosure attached to the CFMF such as windows, storefront, door frames, louvers. Accommodate supports and attachments for cladding that may not include point supports not evenly distributed over each framing member.
- H. Support for Flashing and Terminations: Coordinate the layout of the CFMF and provide backing at locations necessary for anchorage of termination bars or similar devices required for waterproofing membranes, roofing membranes, air barrier/water resistant barrier membranes, underlayments and any flashing or accessories associated with those membranes.
- I. Backup Wall Panelization: The CFMF, sheathing, air moisture barrier, insulation and girts if any may be panelized at an offsite fabrication plant. Leave out an area of insulation and girts approximately 6" wide around full perimeter of panel to allow for completion of field sealing of air moisture barrier and completion of insulation. Panelization schemes that include cladding are not allowed.
- J. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.
 1. Comply with requirements indicated in the structural drawings.
 2. Design Loads: Comply with Loading indicated in Section 01 83 16 and as indicated on Sheet S-001.
 3. Snow Loads: Support snow loads indicated on Structural Drawings for any surface more than 45 degrees off vertical.
 4. Design for loads for shipping and erection for optional panelized backup wall assemblies

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5. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
 - a. Exterior Non-Load-Bearing Framing and Miscellaneous Framing: Horizontal deflection of $1/240$ of the wall height for framing supporting metal panels, $1/720$ of the wall height for framing supporting masonry veneer.
 - b. Exterior Soffit Framing: Vertical deflection of $1/240$ of span except $1/360$ for soffits supporting Portland cement stucco.
 6. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.
 7. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
 - a. Upward and downward movement of $1/2$ " inch.
 8. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.
 9. Design framing to support loads from overlying cladding and veneers, from adjacent curtain wall framing, and from other adjacent construction that imparts a load on the cold formed metal framing.
 10. Design framing to allow for control joints in sheathing, including providing continuous support at edges of sheathing at control joints. Refer to the sheathing specification for spacing of control joints.
- K. Cold-Formed Steel Framing Design Standards:
1. Floor and Roof Systems: AISI S210.
 2. Wall Studs: AISI S211.
 3. Headers: AISI S212.
 4. Lateral Design: AISI S213.
- L. AISI Specifications and Standards: Unless more stringent requirements are indicated, comply with AISI S100 and AISI S240.
- M. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency.
1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

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2.2 COLD-FORMED STEEL FRAMING, GENERAL

- A. Framing Members, General: Comply with AISI S240 for conditions indicatedSteel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:
 - 1. Grade: As required by structural performance.
 - 2. Coating: CPO 60, G60 (Z180) or equivalent.
- C. Steel Sheet for Vertical Deflection, Rigid, and Foundation Clips,: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:
 - 1. Grade: As required by structural performance.
 - 2. Coating: CP 90: G90 (Z275).

2.3 EXTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0428 inch and as required by structural performance.
 - 2. Minimum Flange Width: 1-5/8 inches and as required by structural performance.
- B. Steel Track: U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and matching base-metal thickness of steel studs.
 - 1. Track at head or sill of curtain wall, doors, louvers and other rough openings for attachment of anchors and wherever indicated on drawings as "HEAVY":
 - a. Minimum Base-Metal Thickness: Minimum 0.0966 inch.
 - b. Minimum Flange Width: 2 inches and as required by structural performance.
- C. Vertical Deflection Clips: Clips capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
- D. Single Deflection Track: Single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure.
- E. Double Deflection Tracks: Double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.

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2.4 EXTERIOR LOAD-BEARING WALL FRAMING

- A. Steel Studs: C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0428 inch and as required by structural performance.
 - 2. Minimum Flange Width: 1-5/8 inches and as required by structural performance.
- B. Steel Track: U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and matching base-metal thickness of steel studs.
 - 1. Track at head or sill of curtain wall, doors, louvers and other rough openings for attachment of anchors and wherever indicated on drawings as "HEAVY":
 - a. Minimum Base-Metal Thickness: Minimum 0.0966 inch.
 - b. Minimum Flange Width: 2 inches and as required by structural performance.

2.5 SOFFIT FRAMING

- A. Exterior Soffit Frame: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0428
 - 2. Flange Width: 1-5/8 inches minimum.

2.6 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.
- B. Provide accessories of thickness and configuration required by Delegated Design Engineer to comply with indicated performance criteria.
- C. Curtain Wall Fire Resistive Joint System Reinforcing Angle: Minimum 1 1/2" by 1 1/2" by 0.329" continuous angle notched to fit over studs.

2.7 ANCHORS, CLIPS, AND FASTENERS

- A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.

- B. Anchor Bolts: ASTM F 1554, Grade as required by structural performance, threaded carbon-steel bolts and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153/A 153M, Class C.
- C. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E 488 conducted by a qualified testing agency.
- D. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.
 - 1. Powder-Actuated Anchors are not allowed where anchor acts primarily to resist tension or pull-out loading.
- E. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.
 - 1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.

2.8 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: SSPC-Paint 20 or MIL-P-21035B or ASTM A 780.
- B. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents, complying with ASTM C 1107/C 1107M, with fluid consistency and 30-minute working time.
- C. Shims: Load bearing, high-density multimonomer plastic, and nonleaching; or of cold-formed steel of same grade and coating as framing members supported by shims.
- D. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

2.9 FABRICATION

- A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
 - 1. Fabricate framing assemblies using jigs or templates.
 - 2. Cut framing members by sawing or shearing; do not torch cut.

3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by no fewer than three exposed screw threads.
 4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.
- B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.
- C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
1. General: Install Tolerances as required to:
 - a. Match approved Mockup and Samples.
 - b. Comply with performance criteria.
 - c. Comply with manufacturer's written instructions.
 - d. Achieve tolerances indicated for Final Work in Section 01 83 16.
 2. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
 3. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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3.2 PREPARATION

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

3.3 INSTALLATION, GENERAL

- A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.
- B. Install cold-formed steel framing according to ASTM C1007 and AISI S200 and to manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install shop or field-fabricated, cold-formed framing and securely anchor to supporting structure.
 - 1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.
- D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
 - 1. Cut framing members by sawing or shearing; do not torch cut.
 - 2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.
- E. Install framing members in one-piece lengths.

- F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- G. Install insulation, specified in Section 07 21 00 "Thermal Insulation," in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
- H. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

3.4 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.
 - 1. Provide heavy gage deep leg track at head and sill of storefront, curtain wall framing, doors, louvers and other rough openings and as indicated.
- B. Provide heavy gage angles, clips and other accessories as indicated.
- C. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:
 - 1. Stud Spacing: 16 inches maximum or closer spacing as required for structural performance.
- D. Set studs plumb, except as needed for diagonal bracing or required for non-plumb walls or warped surfaces and similar requirements.
- E. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
 - 1. Install single deep-leg deflection tracks and anchor to building structure or install double deep-leg deflection tracks and anchor outer track to building structure.
 - 2. Connect vertical deflection clips to bypassing studs and anchor to building structure.
- F. Install double studs at vertical control joints in sheathing and at horizontal control joints in sheathing not located at deflection tracks. Coordinate layout of control joints with sheathing manufacturer's instructions.
- G. Do not bridge movement joints or expansion joints with framing.
- H. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.

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1. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.
 - a. Install solid blocking at maximum 96-inch centers or closer spacing as required for structural performance.
2. Bridging: Contractor may select from three options below:
 - a. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
 - b. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
 - c. Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- I. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.
- J. Install blocking, strapping, "kitchen metal" or other metal accessories where indicated and where required to support changes in sheathing, anchorage for cladding, anchorage for interior features attached to the walls and as required for proper support of work.
- K. Curtain Wall Fire Resistive Joint System Reinforcing Angle: Install continuous angles at each floor slab and roof deck as indicated and as required to support the fire resistive joint system specified in Division 07.

3.5 INSTALLATION OF LOAD-BEARING WALL FRAMING

- A. Install continuous top and bottom tracks sized to match studs. Align tracks accurately and securely anchor at corners and ends, and at spacings as follows:
 1. Anchor Spacing: Maximum 24 inches on center and as required to comply with indicated performance.
- B. Squarely seat studs against top and bottom tracks, with gap not exceeding 1/8 inch (3 mm) between the end of wall-framing member and the web of track.
 1. Fasten both flanges of studs to top and bottom tracks.
 2. Space studs as follows:
 - a. Stud Spacing: Maximum 16 inches on-center.

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- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar configurations.
- D. Align studs vertically where floor framing interrupts wall-framing continuity. Where studs cannot be aligned, continuously reinforce track to transfer loads.
- E. Align floor and roof framing over studs according to AISI S200, Section C1. Where framing cannot be aligned, continuously reinforce track to transfer loads.
- F. Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure.
- G. Install headers over wall openings wider than stud spacing. Locate headers above openings. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.
 - 1. Frame wall openings with not less than a double stud at each jamb of frame. Fasten jamb members together to uniformly distribute loads.
 - 2. Install tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with clip angles or by welding, and space jack studs same as full-height wall studs.
- H. Install supplementary framing, blocking, and bracing in stud framing indicated to support fixtures, equipment, services, casework, heavy trim, furnishings, and similar work requiring attachment to framing.
 - 1. If type of supplementary support is not indicated, comply with stud manufacturer's written recommendations and industry standards in each case, considering weight or load resulting from item supported.
- I. Install horizontal bridging in stud system, spaced vertically 48 inches maximum. Fasten at each stud intersection.
 - 1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs with a minimum of two screws into each flange of the clip angle for framing members up to 6 inches deep.
 - 2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges, and secure solid blocking to stud webs or flanges.
 - 3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- J. Install steel sheet diagonal bracing straps to both stud flanges; terminate at and fasten to reinforced top and bottom tracks. Fasten clip-angle connectors to multiple studs at ends of bracing and anchor to structure.

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- K. Install miscellaneous framing and connections, including supplementary framing, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.6 FIELD QUALITY CONTROL

- A. Erection Tolerances: Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
 - 1. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
 - 2. General: Install Tolerances as required to:
 - a. Match approved Mockup and Samples.
 - b. Comply with performance criteria.
 - c. Comply with manufacturer's written instructions.
 - d. Achieve tolerances indicated for Final Work in Section 01 83 16.
- B. Testing and Inspection: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports required for compliance with Special Inspections requirements of building code.
- C. Remove and replace work where test results indicate that it does not comply with specified requirements.
- D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.7 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 05 50 00

METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Miscellaneous metal items indicated and specified, or otherwise necessary for completion of the work. Work of this section includes, but is not limited to, the following:
1. Ferrous and non-ferrous metalwork detailed on the drawings as a component part of other assemblies, but not specified elsewhere.
 2. Miscellaneous steel framing and supports including:
 - a. Mechanical and electrical equipment.
 - b. Applications where framing and supports are not specified in other Sections.
 3. Shelf angles.
 4. Metal ladders.
 5. Metal ships ladders.
 6. Miscellaneous steel trim including steel angle corner guards, steel edgings, and loading-dock edge angles.
 7. Metal bollards.
 8. Abrasive metal nosings.
 9. Loose bearing and leveling plates.
 10. Elevator machine beams, hoist beams, and divider beams.
- B. Products furnished, but not installed, under this Section:
1. Loose steel lintels.
 2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
 3. Steel weld plates and angles for casting into concrete.

1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design metal fabrications, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
1. Structural Performance: Design metal fabrications to withstand the effects of gravity loads within limits and under conditions indicated.
 2. Seismic Performance: Provide metal fabrications capable of withstanding the effects of earthquake motions determined according to ASCE/SEI 7.
 3. Structural Performance of Ladders: Ladders, shall withstand the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.

- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
 - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - 1. Metal nosings and treads.
 - 2. Paint products.
 - 3. Grout.
- B. Shop Drawings: Show fabrication and installation details for metal fabrications.
 - 1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
- C. Samples for Verification: For each type and finish of extruded nosing.
- D. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.6, "Structural Welding Code - Stainless Steel."

1.5 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 and steel weld plates and angles for casting into concrete. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces without blemishes.

2.2 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.
- C. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.
- D. Steel Tubing: ASTM A 500, cold-formed steel tubing.
- E. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40) unless otherwise indicated.
- F. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
 - 1. Size of Channels: As indicated in Drawings.
 - 2. Material: Cold-rolled steel, ASTM A 1008/A 1008M, structural steel, Grade 33 (Grade 230); 0.0677 inch (1.7 mm) minimum thickness; unfinished and hot-dip galvanized after fabrication.
 - 3. Accessories:
 - a. Closure Strips: Manufacturer standard snap-in product to close exposed channel openings.
- G. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M.

2.3 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
 - 1. Provide stainless-steel fasteners for fastening aluminum.
 - 2. Provide stainless-steel fasteners for fastening stainless steel.
- B. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.

- C. Post-Installed Anchors: Torque-controlled expansion anchors.
 - 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 (A1) stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).
- D. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches (41 by 22 mm) by length indicated with anchor straps or studs not less than 3 inches (75 mm) long at not more than 8 inches (200 mm) o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

2.4 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Shop Primers: Provide primers that comply with Division 09 Section "Painting" and Division 09 Section "High-Performance Coatings."
- C. Zinc-Rich Primer: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
- 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.

2.5 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Use connections that maintain structural value of joined pieces.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges. Remove sharp or rough areas on exposed surfaces.
- C. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended.
- D. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Locate joints where least conspicuous.

- E. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- F. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors not less than 8 inches (200 mm) from ends and corners of units and 24 inches (600 mm) o.c.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

2.7 SHELF ANGLES

- A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete and/or concrete masonry. Provide horizontally slotted holes to receive 3/4 inch (19 mm) bolts, spaced not more than 6 inches (150 mm) from ends and 24 inches (600 mm) o.c., unless otherwise indicated. Hole diameter or slot width not to exceed bolt diameter plus 1/16 inch.
- B. Hot-dip galvanize shelf angles located in exterior walls. Hot-dip galvanize and paint shelf angles exposed to view.
- C. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.8 METAL LADDERS

- A. General:
 - 1. For elevator pit ladders, comply with ASME A17.1.
- B. Aluminum Ladders:
 - 1. Manufacturer and Product: UPNOVR, Inc., Hatch Access Heavy Duty Vertical Ladder – Part No. U-200, as basis of design.
 - a. Material: Aluminum 6061 – T6.
 - b. Finish: Standard mill.
 - c. Side rails: 1-3/4 inches by 3 inches tube with 1/8 inch wall thickness.
 - d. Rungs: 1-1/4 inches square tube by 18 inches long, corrugated material.
 - 1) Space 12 inches on center.
 - 2) Fabricate by welding to centerline of side rails.
 - e. Loading Capacity: 1,000 pounds.
 - f. Support Brackets:

- 1) Wall Brackets: 2 by 1/4 inch minimum flat bar aluminum.
 - a) Anchor at top and bottom of ladder and every 48 inches, on center, intermediately.
 - b) Allow 7 inches minimum clearance from wall to center line of rungs.
 - 2) Floor Brackets: Anchor side rails with 2 by 1/4 inch minimum flat bar aluminum.
- g. Height: See Drawings.

2.9 METAL SHIPS LADDERS

- A. Provide metal ships ladders where indicated. Fabricate of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.
1. Manufacturer and Product: UPNOVR, Inc., Hatch Access Ladder – Part No. U-502, as basis of design.
 - a. Material: Aluminum 6061 – T6.
 - b. Finish: Standard mill.
 - c. Treads: 6 inches deep by 1-3/4 inches high by 24 inches wide aluminum extrusion section with corrugated surface.
 - 1) Space 12 inches on center.
 - 2) Fabricate by welding to ladder stringer.
 - d. Loading Capacity: 500 pounds.
 - e. Hand Railing: 1-1/4 inches aluminum schedule 40 pipe, both sides.
 - 1) Extend beyond top step per OSHA standards.
 - f. Support Brackets: Top wall brackets and bottom floor brackets fabricated from 2 by 1/4 inch minimum flat bar aluminum.
 - g. Height: See Drawings.
 - h. Angle of Inclination: See Drawings.

2.10 MISCELLANEOUS STEEL TRIM

- A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
- C. Hot-dip galvanize exterior miscellaneous steel trim.
- D. Prime miscellaneous steel trim with primer specified in Division 09 Section "High-Performance Coatings."

2.11 METAL BOLLARDS

- A. Fabricate metal bollards from Schedule 40 steel pipe.
 - 1. Cap bollards with 1/4-inch- (6.4-mm-) thick steel plate.
- B. Fabricate sleeves for bollard anchorage from steel pipe or tubing with 1/4 inch (6.4 mm) thick steel plate welded to bottom of sleeve.
- C. Fabricate internal sleeves for removable bollards from Schedule 40 steel pipe or 1/4 inch (6.4 mm) wall-thickness steel tubing with an OD approximately 1/16 inch (1.5 mm) less than ID of bollards. Match drill sleeve and bollard for 3/4 inch (19 mm) steel machine bolt.
- D. Prime bollards with primer specified in Division 09 Sections.

2.12 ABRASIVE METAL NOSINGS

- A. Extruded and Cast-Metal Units: Cast iron, with an integral-abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Safety Tread Co., Inc.
 - b. Balco Inc.
 - c. Wooster Products Inc.
- B. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.
- C. Drill for mechanical anchors and countersink. Locate holes not more than 4 inches (100 mm) from ends and not more than 12 inches (300 mm) o.c.
- D. Apply bituminous paint to concealed surfaces of cast-metal units.
- E. Apply clear lacquer to concealed surfaces of extruded units.

2.13 LOOSE BEARING AND LEVELING PLATES

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

2.14 LOOSE STEEL LINTELS

- A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated.
- B. Hot-dip galvanize loose steel lintels located in exterior walls. Hot-dip galvanize and paint loose lintels exposed to view.

- C. Prime loose steel lintels located in exterior walls with primer specified in Division 09 Sections.

2.15 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal fabrications after assembly.

2.16 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize steel items exposed to weather or moisture, items located in exterior walls, items supporting exterior masonry including backup, or as indicated on drawings. Hot-dip galvanize items to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
- B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean metal fabrications of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.
- C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
- D. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces using methods recommended in writing by coating manufacturer, but not less than the following: requirements indicated below:
 - 1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 3. Other Items: SSPC-SP 3, "Power Tool Cleaning."
- E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 INSTALLING METAL BOLLARDS

- A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.
- B. Anchor bollards in concrete with pipe sleeves preset and anchored into concrete. Fill annular space around bollard solidly with nonshrink, nonmetallic grout.
- C. Fill bollards solidly with concrete, mounding top surface to shed water.

3.3 INSTALLING BEARING AND LEVELING PLATES

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

3.4 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 1. Apply by brush or spray to provide a minimum 2.0 mil (0.05 mm) dry film thickness.

- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 Section "Painting" and Division 09 "High-Performance Coatings."
- C. Galvanized Surfaces: Clean field welds and damaged areas and repair galvanizing to comply with ASTM A 780/A 780M, in accordance with Annex A1 zinc solder or Annex A3 metallizing. Repair method in accordance with Annex A2 galvanizing repair paint not permitted.

END OF SECTION

NOT FOR BID

SECTION 05 51 00

METAL STAIRS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Commercial steel stairs with concrete-filled treads and platforms for egress stairs with for egress stairs within enclosed shafts.
 - a. Steel tube railings and guards attached to metal stairs.
 - b. Steel tube handrails attached to walls adjacent to metal stairs.
2. Monumental (architectural grade) stairs with precast terrazzo treads.

B. Related Sections:

1. Glazed decorative metal railings at monumental stairs, as specified in Section 05 73 13.

1.2 COORDINATION

- 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 with one another.
- B. Coordinate installation of anchorages for metal stairs. Furnish setting drawings, templates, and installation instructions. Furnish items to be embedded in concrete or masonry.
- C. Coordinate locations of hanger rods and struts with other work so that they do not encroach on required stair width and are within the fire-resistance-rated stair enclosure.

1.3 ACTION SUBMITTALS

A. Product Data: For metal stairs and the following:

1. Stair treads and platforms.
2. Handrail wall brackets.
3. Paint products.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Indicate profile and dimensions of precast terrazzo treads.
2. Indicate locations of anchors, weld plates, and blocking for attachment of wall-mounted handrails.

C. Samples for Verification: For each type and finish of precast terrazzo tread.

- D. Delegated-Design Submittal: For stairs, railings and guards, and precast terrazzo treads, include analysis data signed and sealed by the qualified professional engineer responsible for their preparation for the following:

1. Commercial stairs.
2. Architectural stairs.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer's experience with providing delegated-design engineering services of the kind indicated, including documentation that engineer is licensed in the State in which Project is located.
- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Alfab, Inc.
 2. American Stair, Inc.
 3. Sharon Companies Ltd. (The).
 4. Lapeyre Stair Inc.
 5. Worthington Metal Fabricators.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design stairs and railings.
- B. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
1. Uniform Load: 100 lbf/sq. ft.

2. Concentrated Load: 300 lbf applied on an area of 4 sq. in.
 3. Uniform and concentrated loads need not be assumed to act concurrently.
 4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
 5. Limit deflection of treads, platforms, and framing members to $L/360$ or $1/4$ inch, whichever is less.
 6. Refer to Drawings for additional information and framing requirements.
 7. Railing Loads: Per applicable Building Code.
- C. Structural Performance of Railings and Guards: Railings and guards, 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. applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 2. Infill of Guards:
 - a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
 - b. Infill load and other loads need not be assumed to act concurrently.
- D. Seismic Performance of Stairs: Metal stairs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.3 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- C. Steel Tubing for Railings and Guards: ASTM A500/A500M (cold formed).
- D. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.
- E. Steel Tubing: ASTM A 500 (cold formed).
- F. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.
- G. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 coating, either commercial steel, Type B, or structural steel, Grade 33, unless another grade is required by design loads.

2.4 FASTENERS

- A. General: Provide zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.
- B. Fasteners for Anchoring Railings and Guards to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings and guards to other types of construction indicated and capable of withstanding design loads.
- C. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.
- D. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.
- E. 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/E 488M, 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, Class Fe/Zn 5, unless otherwise indicated.
 - 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 2 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

2.5 MISCELLANEOUS MATERIALS

- A. Universal 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.
- B. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.
- E. Concrete Materials and Properties: Comply with requirements in Section 03 30 00 "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
- F. Nonslip-Aggregate Concrete Finish: Factory-packaged abrasive aggregate made from fused, aluminum-oxide grits or crushed emery; rustproof and nonglazing; unaffected by freezing, moisture, or cleaning materials.
- G. Welded Wire Reinforcement: ASTM A 185/A 185M, 6 by 6 inches, W1.4 by W1.4, unless otherwise indicated.

2.6 FABRICATION, GENERAL

- A. Provide complete stair assemblies, including metal framing, hangers, struts, railings and guards, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.
 - 1. Join components by welding unless otherwise indicated.
 - 2. Use connections that maintain structural value of joined pieces.
- B. Assemble stairs, railings and guards in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- E. Form exposed work with accurate angles and surfaces and straight edges.
- F. Weld connections to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Weld exposed corners and seams continuously unless otherwise indicated.
 - 5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards."
 - a. Commercial Stairs:
 - 1) At Support Angles under Steel Pans: Type 2 weld; completely sanded joint, some undercutting and pinholes permitted.
 - 2) All other Locations: Type 3 welds; partially dressed weld with spatter removed.
 - b. Architectural Stairs: Type 1 welds; no evidence of welded joint.
- G. Commercial and Architectural Stairs: Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.

2.7 FABRICATION OF STEEL-FRAMED STAIRS

- A. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," Commercial Class, unless more stringent requirements are indicated.

B. Stair Framing:

1. Fabricate stringers of steel channels.
 - a. Provide closures for exposed ends of channel stringers.
2. Construct platforms of steel channel headers and miscellaneous framing members as needed to comply with performance requirements.
3. Weld or bolt stringers to headers; weld or bolt framing members to stringers and headers.
 - a. Commercial Stairs: Fabricate and join so bolts are not exposed on finished surfaces.
4. Where stairs are enclosed by gypsum board shaft-wall assemblies, provide hanger rods or struts to support landings from floor construction above or below. Locate hanger rods and struts where they do not encroach on required stair width and are within the fire-resistance-rated stair enclosure.
5. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.

C. Metal Pan Stairs: Form risers, subread pans, and subplatforms to configurations shown from steel sheet of thickness minimum 0.067 inch thick.

1. Directly weld metal pans to stringers; locate welds on top of subreads where they are concealed by concrete fill. Do not weld risers to stringers.
2. Attach risers and subreads to stringers with brackets made of steel angles or bars. Weld brackets to stringers and attach metal pans to brackets by welding, riveting, or bolting.
3. Provide subplatforms of configuration indicated or, if not indicated, the same as subreads. Weld subplatforms to platform framing.
 - a. Smooth Soffit Construction: Construct subplatforms with flat metal under surfaces to produce smooth soffits.

2.8 FABRICATION OF STAIR RAILINGS AND GUARDS

A. Fabricate railings to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of tube, post spacings, and anchorage, but not less than that needed to withstand indicated loads.

1. Rails and Posts: As indicated, 1-1/2-inch- diameter, and top and bottom rails and 1-1/2-inch- (38-mm-) pipe posts.
2. Picket Infill: 5/8-inch- round pickets spaced less than 4 inches clear.
3. Intermediate Rails Infill: 1-1/2-inch- diameter intermediate rails spaced less than 24 inches clear.

B. Welded Connections: Fabricate railings with welded connections. Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

1. Finish welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 3 welds: partially dressed weld with spatter removed.
2. For welds in hand railings comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 welds: no evidence of a welded joint.

- C. Form changes in direction of railings by bending.
- D. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- E. Close exposed ends of railing members with prefabricated end fittings.
- F. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated.
- G. Connect posts to stair framing by direct welding.
- H. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work.
 - 1. For galvanized railings, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous-metal components.
 - 2. For nongalvanized railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors embedded in exterior masonry and concrete construction.
- I. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.

2.9 FINISHES

- A. Finish metal stairs after assembly.
- B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
 - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- C. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 3, "Power Tool Cleaning."
 - 1. Remove all shop markings prior to applying the shop primer.
- D. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLING METAL STAIRS

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.
- C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.
- D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- E. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- F. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.
- G. Place and finish concrete fill for treads and platforms to comply with Section 03 30 00 "Cast-in-Place Concrete."
 - 1. Install rubber stair accessories according to manufacturer written instructions and Section 09 65 13.
- H. Install precast terrazzo treads according to manufacturer written instructions and Section 09 66 23.

3.2 INSTALLATION OF RAILINGS AND GUARDS

- A. Adjust railing and guard systems before anchoring to ensure matching alignment at abutting joints with tight, hairline joints.
 - 1. Space posts at spacing indicated or, if not indicated, as required by design loads.
 - 2. Plumb posts in each direction, within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).
 - 3. Align rails and guards so variations from level for horizontal members and variations from parallel with rake of stairs for sloping members do not exceed 1/4 inch in 12 feet (6 mm in 3.5 m).
 - 4. Secure posts, rail ends, and guard ends to building construction as follows:
 - a. Anchor posts to steel by welding or bolting to steel supporting members.
 - b. Anchor handrail and guard ends to concrete and masonry with steel round flanges welded to rail and guard ends and anchored with post-installed anchors and bolts.

B. Attach handrails to wall with wall brackets.

1. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
2. Secure wall brackets to building construction as required to comply with performance requirements.

3.3 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

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SECTION 05 53 13

BAR GRATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Metal bar gratings for exterior metal stairs, and metal frames and supports for gratings for MEP shafts.

1.2 COORDINATION

- 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 with one another.
- B. Coordinate installation of anchorages for gratings, grating frames, and supports. 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. Delegated-Design Submittal: For gratings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Anchorage devices for gratings.
2. Paint products.

B. Shop Drawings: Include plans, sections, details, and attachments to other work.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.6 FIELD CONDITIONS

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Alabama Metal Industries Corporation, a Gibraltar Industries company.
 2. All American Grating.
 3. Ohio Gratings, Inc.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design gratings.
- B. Structural Performance: Gratings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
1. Walkways and Elevated Platforms Other Than Exits: Uniform load of 100 lbf/sq. ft.
 2. Sidewalks and Vehicular Driveways, Subject to Trucking: Uniform load of 250 lbf/sq. ft. or concentrated load of 8000 lbf, whichever produces the greater stress.
 3. Limit deflection to L/360 or 1/4 inch, whichever is less.
- C. Seismic Performance: Gratings shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. Component Importance Factor: 1.5.

2.3 METAL BAR GRATINGS

- A. Metal Bar Grating Standards: Comply with NAAMM MBG 532, "Heavy-Duty Metal Bar Grating Manual."
1. Bearing Bar Thickness: As required to comply with structural performance requirements.
 2. Crossbar Spacing: 2 inches o.c.
 3. Traffic Surface: As indicated.

4. Steel Finish: Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. of coated surface.

2.4 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Steel Bars for Bar Gratings: ASTM A 36/A 36M or steel strip, ASTM A 1011/A 1011M or ASTM A 1018/A 1018M.
- C. Wire Rod for Bar Grating Crossbars: ASTM A 510.
- D. Uncoated Steel Sheet: ASTM A 1011/A 1011M, structural steel, Grade 30.
- E. Galvanized-Steel Sheet: ASTM A 653/A 653M, structural quality, Grade 33, with G90 coating.

2.5 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563, and flat washers.
- C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts, flat washers; ASTM F 593 for bolts and ASTM F 594 for nuts, Alloy Group 1.
- D. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563, flat washers.
- E. Post-Installed Anchors: Torque-controlled expansion 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/E 488M, 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, Class Fe/Zn 5, unless otherwise indicated.

2.6 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- B. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

2.7 FABRICATION

- A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling

limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

- B. Cut, drill, and punch material 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.
- C. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.
- D. Fit exposed connections accurately together to form hairline joints.
- E. Welding: Comply with AWS recommendations and the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
- F. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.
- G. Removable Grating Sections: Fabricate with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners of type indicated or, if not indicated, as recommended by manufacturer for attaching to supports.
 - 1. Provide no fewer than four weld lugs for each heavy-duty grating section, with each lug shop welded to two bearing bars.
 - 2. Provide no fewer than four flange blocks for each section of aluminum I-bar grating, with block designed to fit over lower flange of I-shaped bearing bars.
 - 3. Furnish threaded bolts with nuts and washers for securing grating to supports.
 - 4. Furnish galvanized malleable-iron flange clamp with galvanized bolt for securing grating to supports. Furnish as a system designed to be installed from above grating by one person.
- H. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.
 - 1. Edge-band openings in grating that interrupt four or more bearing bars with bars of same size and material as bearing bars.
- I. Do not notch bearing bars at supports to maintain elevation.

2.8 GRATING FRAMES AND SUPPORTS

- A. Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.
 - 1. Unless otherwise indicated, fabricate from same basic metal as gratings.
 - 2. Equip units indicated to be cast into concrete or built into masonry with integrally welded anchors. Unless otherwise indicated, space anchors 24 inches o.c. and provide minimum

anchor units in the form of steel straps 1-1/4 inches wide by 1/4 inch thick by 8 inches long.

- B. Galvanize steel frames and supports in the following locations:

1. Exterior.

2.9 STEEL FINISHES

- A. Finish gratings, frames, and supports after assembly.
- B. Galvanizing: Hot-dip galvanize items to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
- C. Shop prime gratings, frames, and supports not indicated to be galvanized unless otherwise indicated.
1. Shop prime with universal shop primer.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.
- D. Fit exposed connections accurately together to form hairline joints.
1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- E. Field Welding: Comply with AWS recommendations and the following:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.

3.2 INSTALLING METAL BAR GRATINGS

- A. General: Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.
- B. Install gratings running parallel to traffic.
- C. Attach nonremovable units to supporting members by welding where both materials are same; otherwise, fasten by bolting.

3.3 ADJUSTING AND CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION

SECTION 05 73 13

GLAZED DECORATIVE METAL RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior post-supported railings with glass-infill panels at monumental stairs.

1.2 DEFINITIONS

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

1.3 COORDINATION AND SCHEDULING

- A. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver items to Project site in time for installation.

1.4 PREINSTALLATION MEETINGS

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

1.5 ACTION SUBMITTALS

A. Product Data:

1. Metal railings assembled from standard components.
2. Glass products.
3. Fasteners.
4. Bituminous paint.
5. Nonshrink, nonmetallic grout.
6. Anchoring cement.

- B. Shop Drawings: Include plans, elevations, sections, and attachment details.

- C. Samples for Verification: For each type of exposed finish required.

1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
2. Base channel.

3. Each type of glass and glass edge required.
4. Fittings and brackets.
5. Assembled Samples of railing systems, made from full-size components, including top rail, post, handrail, glass-infill panels. Show method of finishing members at intersections. Samples need not be full height.

- D. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer.
- B. Mill Certificates: Signed by manufacturers of stainless steel products, certifying that products furnished comply with requirements.
- C. Product Test Reports: For tests performed by a qualified testing agency, in accordance with ASTM E894, ASTM E935, ASTM E2353, and ASTM E2358.
- D. Evaluation Reports: From ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.
1. For glazed decorative metal railings.
 2. For post-installed anchors.
- E. Preconstruction test reports.

1.7 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.

1.8 WARRANTY

- A. Manufacturer's Special Warranty for Laminated Glass: Glazed decorative metal railing manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. C. R. Laurence Co., Inc.
 - 2. Julius Blum & Co., Inc.
 - 3. CraneVeyor Corp.
 - 4. Livers Bronze Co.
 - 5. Wylie Systems.
- B. Source Limitations for Laminated Glass: Obtain from single source from single manufacturer.
- C. Source Limitations for Decorative Metal Railing Components: Obtain from single source from single manufacturer for each component and installation method.
- D. Product Options: Information on Drawings and in the Specifications establishes requirements for railing system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
 - 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.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design glazed decorative metal railings, including attachment to building construction.
- B. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
 - 1. Stainless Steel: 60 percent of minimum yield strength.
 - 2. Glass: 25 percent of mean modulus of rupture (50 percent probability of breakage), as listed in "Mechanical Properties" in AAMA CW-12, "Structural Properties of Glass."
- C. 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. Glass-Infill Panels:

- 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. Structural Glass Railings: Support each section of top rail and handrail by a minimum of three glass panels or by other means so railings will remain in place if any one glass panel fails.
 - a. Support top rail and handrail ends such that railings remains in place if end glass panel fails.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.3 METALS, GENERAL

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

2.4 STAINLESS STEEL

- A. Pipe: ASTM A312/A312M, Grade TP 304.
- B. Castings: ASTM A743/A743M, Grade CF 8 or Grade CF 20.
- C. Sheet, Strip, Plate, and Flat Bar: ASTM A666 or ASTM A240/A240M, Type 304.
- D. Bars and Shapes: ASTM A276, Type 304.

2.5 GLASS AND GLAZING PRODUCTS, GENERAL

- A. Glazing Publications: Comply with written instructions 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: "GANA Laminated Glazing Reference Manual" and "GANA Glazing Manual."
- B. Safety Glazing: Glazing shall comply with 16 CFR 1201, Category II.
- C. Safety Glazing Labeling: Permanently mark glass with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction or manufacturer. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

- D. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear), Class 1 and low-iron clear, or Class 2 (tinted) as indicated, Quality-Q3.
- E. Glazing Cement and Accessories for Structural Glass Railings: Glazing cement, setting blocks, shims, and related accessories as recommended or supplied by railing manufacturer for installing structural glazing in metal base channels.
- F. Glazing Gaskets for Glass-Infill Panels: Glazing gaskets and related accessories as recommended or supplied by railing manufacturer for installing glass-infill panels in post-supported railings.

2.6 GLASS HANDRAILS AND GUARDS

- A. Laminated Glass Handrails and Guards: ASTM C1172, Type II with two plies of glass bonded together by an interlayer.
 - 1. Construction: Laminate glass with ionoplast polymer interlayer to comply with interlayer manufacturer's written instructions.
 - 2. Interlayer Thickness: 0.060 inch (1.52 mm).
 - 3. Kind: LT (laminated tempered).
 - 4. Glass Color: Inner-ply clear; outer-ply clear.
 - 5. Interlayer Color: Clear.
 - 6. Glass Plies for Glass-Infill Panels: Thickness required by structural loads, but not less than 3.0 mm each.

2.7 FASTENERS

- A. Fastener Materials: Unless otherwise indicated, provide the following:
 - 1. Stainless Steel Components: Type 304 stainless steel fasteners.
 - 2. Dissimilar Metals: Type 304 stainless steel fasteners.
- B. Fasteners for Anchoring to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.
- C. Provide concealed fasteners for interconnecting railing components and for attaching railings to other work unless otherwise indicated.
 - 1. Provide tamper-resistant flat-head machine screws for exposed fasteners unless otherwise indicated.
- D. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to design load, in accordance with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 or ICC-ES AC308.
 - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/ASTM F1941M, Class Fe/Zn 5, unless otherwise indicated.

2.8 MISCELLANEOUS MATERIALS

- A. Handrail Brackets: Cast stainless steel, center of rail 2-1/2 inches (63.5 mm) from face of structural glass balusters.
- B. Glass Shoe Molding System:
 - 1. Manufacturer and Product: Wagner, Inc. PanelGrip, as basis of design.
- C. Cap Railing: Stainless steel square metal cap for glass panel, 1-1/2 inches.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- E. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.9 FABRICATION OF METAL RAILINGS

- A. 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 (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. 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. 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.
- H. Form changes in direction as follows:
 - 1. As detailed.
- I. Bend members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

- J. Close exposed ends of hollow railing members with prefabricated end fittings.
- K. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, handrail brackets, 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.
- L. 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.
- M. For railing posts set in concrete, provide stainless steel sleeves not less than 6 inches (150 mm) long with inside dimensions not less than 1/2 inch (13 mm) greater than outside dimensions of post, with metal plate forming bottom closure.

2.10 FABRICATION OF GLASS PANELS AND BALUSTERS

- A. Fabricate glass to sizes and shapes required; provide for proper edge clearance and bite on glazing panels.
- B. Glass-Infill Panels: Provide laminated, tempered glass-infill panels.
 - 1. Edge Finish: Clean-cut or flat-grind edges to produce smooth, square edges with slight chamfers at junctions of edges and faces.

2.11 METAL FINISH REQUIREMENTS, GENERAL

- 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.

2.12 STAINLESS STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - 1. Run grain of directional finishes with long dimension of each piece.
 - 2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

- C. Stainless Steel Tubing Finishes:
 - 1. 180-Grit Polished Finish: Uniform, directionally textured finish.
- D. Stainless Steel Sheet, Strip, Plate, and Bar Finishes:
 - 1. Directional Satin Finish: ASTM A480/A480M, No. 4.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Comply with Drawings and manufacturer's written instructions for installing glazed decorative metal railings, accessories, and other components.
- B. Windborne-Debris Resistance: Anchor glazed decorative metal railings to structure using anchoring method, fastener type, and fastening frequency identical to that used in windborne-debris-resistance testing.
- C. Perform cutting, drilling, and fitting required for installing metal railings.
 - 1. Fit exposed connections together to form tight, hairline joints.
 - 2. Install railings level, plumb, square, true to line; without distortion, warp, or rack.
 - 3. Set railings accurately in location, alignment, and elevation; measured from established lines and levels.
 - 4. Do not weld, cut, or abrade surfaces of metal 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.
 - 5. Set posts plumb within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).
 - 6. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet (5 mm in 3 m).
- 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.

3.2 METAL RAILING CONNECTIONS

- A. Nonwelded Connections:
 - 1. Use mechanical or adhesive joints for permanently connecting railing components.
 - 2. Use wood blocks and padding to prevent damage to railing members and fittings.
 - 3. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.
- B. Expansion Joints: Install expansion joints at locations indicated, but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches (50 mm) beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches (150 mm) of post.

3.3 METAL ANCHORING POSTS

- A. Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted in sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions.
- B. Form or core-drill holes not less than 5 inches (125 mm) deep and 3/4 inch (20 mm) larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions.
- C. Anchor posts to metal surfaces with flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
 - 1. For stainless steel railings, weld flanges to posts and bolt to metal-supporting surfaces.

3.4 INSTALLATION OF GLASS BALUSTERS

- A. Post-Supported Railings with Glass-Infill Panels:
 - 1. Install assembly to comply with railing manufacturer's written instructions and with requirements in other Part 3 articles.
 - 2. Erect posts and other metal railing components, and set factory-cut glass-infill panels.
 - 3. Do not cut, drill, or alter glass-infill panels in field. Protect edges from damage.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and to prepare test reports.
- B. Extent and Testing Methodology: Testing agency will randomly select completed railing assemblies for testing that are representative of different railing designs and conditions in the completed Work. Test railings in accordance with ASTM E894, ASTM E935, ASTM E2353, and ASTM E2358 for compliance with performance requirements.
- C. Remove and replace railings where test results indicate that they do not comply with specified requirements unless they can be repaired in a manner satisfactory to Architect and comply with specified requirements.
- D. Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced or additional work with specified requirements.

3.6 CLEANING

- A. Clean stainless steel by washing thoroughly with water and soap, rinsing with clean water, and wiping dry.
- B. Clean and polish glass as recommended in writing by manufacturer. Wash both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion.

3.7 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.
- 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

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SECTION 05 75 00

DECORATIVE FORMED METAL

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Results:
 - 1. Interior column wrap cladding.
- B. Principal Products:
 - 1. Snap together metal column covers.

1.2 PREINSTALLATION MEETINGS

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

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product, including finishing materials.
- B. Shop Drawings: Show fabrication and installation details for column covers.
- C. Samples for Verification: For each type of exposed finish required, prepared on 6-inch- square Samples of metal of same thickness and material indicated for the Work.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: A firm experienced in producing column covers similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 WARRANTY

- A. Manufacturer Warranty: Manufacturer agrees to repair or replace components of sectional doors that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years.
- B. Finish Warranty: Manufacturer agrees to repair or replace components that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Warranty Period: Ten years.

PART 2 - PRODUCTS

2.1 SNAP-TOGETHER COLUMN COVERS

- A. Manufacturer and Product: Metalwerks Column Covers, as basis of design.
 - 1. Material: 1/8 inch aluminum.
 - 2. Vertical Joints: 5/8 inch reveals with recessed batten strips.

2.2 MISCELLANEOUS MATERIALS

- A. Backing Materials: Column cover manufacturer provided or recommended.
- B. Fasteners: Fabricate from same basic metal and alloy.
 - 1. Provide concealed fasteners for interconnecting column covers and attachment to other work unless otherwise indicated.
- C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

2.3 FABRICATION

- A. Fabricate base and ceiling ring to match column covers.
- B. Produce flat, flush surfaces without cracking or grain separation at bends.
- C. Support joints with concealed stiffeners and backing materials.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Locate and place column covers plumb and in alignment with adjacent construction. Perform cutting, drilling, and fitting required to install column covers.
- B. Use concealed anchorages where possible.
- C. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers as indicated.
- D. Corrosion Protection: Apply bituminous paint on concealed surfaces where metals are in direct contact with incompatible substrate materials or could result in corrosion or deterioration of either material or finish.
- E. Apply manufacturer recommended joint sealant at joints of metal column covers.

3.3 ADJUSTING

- A. Touchup Painting: Immediately after erection, clean abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting. SSPC-PA 1 for touching up shop-painted surfaces.
- B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit or provide new units.

3.4 CLEANING AND PROTECTION

- A. Clean surfaces per manufacturer recommendations.
- B. Protect finishes from damage during construction period. Remove temporary protective coverings at time of Substantial Completion.

END OF SECTION

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SECTION 06 00 50

REPAIR OF EXTERIOR CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes repair and restoration of miscellaneous carpentry work related to or supporting the building enclosure as indicated including but not limited to the following:
 - 1. Miscellaneous rough carpentry to repair and restore sub-framing, blocking, sub-fascias and framing.
 - 2. Exterior standing and running trim including window and door perimeter trim, and as indicated.
 - 3. Decorative wood soffit and brackets at cornice.
 - 4. Dutchman and epoxy repairs of existing wood.
 - 5. Standing and running trim indicated to be replaced.
 - 6. Exterior frames and jambs.
 - 7. Panels
 - 8. Wood furring, blocking, shims, and hanging strips for installing work of this section.
 - 9. Shop priming of exterior carpentry work.
- B. Related Requirements:
 - 1. Section 061073 "Exterior Misc Carpentry" for wood blocking related to roofing.
 - 2. Section 080152 "Wood Window Repair" for repairs of existing wood window frame and sash.
 - 3. Section 090190" Exterior Maintenance Repainting" for field painting of the work of this section.

1.2 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements with Work specified in other Sections to ensure that they can be properly supported and installed as indicated.

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. Wood-Preservative Treatment:

- a. Include data and warranty information from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
- b. Indicate type of preservative used and net amount of preservative retained.
- c. Include chemical-treatment manufacturer's written instructions for finishing treated material and manufacturer's written warranty.

2. Fire-Retardant Treatment: Include data and warranty information from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.

B. Shop Drawings:

1. Include dimensioned plans, elevations, sections, and attachment details.
2. Show full-size details.
3. Show locations and sizes of furring, blocking, and hanging strips, including blocking and reinforcement concealed by construction and specified in other Sections.

C. Samples: For each exposed product required in the work.

1. Size:

- a. Panel Products: 12 inches by 24 inches, include edge profile indicated on two sides.
- b. Lumber Products: Match profiles required by 24 inches long, for each shape.
- c. Ornamental Items: One full size sample of each ornamental items.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [architectural woodwork fabricator/manufacturer] [and] [Installer].

B. Evaluation Reports: For the following, from ICC-ES:

1. Preservative-treated wood.
2. Fire-retardant-treated wood.

3. Power-driven fasteners.
4. Post-installed anchors.
5. Expansion anchors.

1.6 QUALITY ASSURANCE

- A. Fabricator's/Manufacturer's Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
1. Fabricator/Manufacturer shall have successfully completed at least 5 projects of similar scope, complexity and quality in the last 3 years. Provide contact information for owners and architects if requested.
 2. Fabricator's/Manufacturer's Certification: Licensed participant in AWI's Quality Certification Program or otherwise acceptable to Architect.
- B. Installer Qualifications: Employs skilled workers who regularly install products similar to those required for this Project and whose products have a record of successful in-service performance.
1. Installer shall have successfully completed at least 5 projects of similar scope, complexity and quality in the last 3 years. Provide contact information for owners and architects if requested.
 2. Licensed participant in AWI's Quality Certification Program or otherwise acceptable to Architect.
- C. Mockups: Repair exterior carpentry as a mockup to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
1. Include:
 - a. Around one typical window.
 - b. Two typical brackets at cornice.
 - c. One section of soffit between brackets at cornice.
 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.]

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with Architectural Woodwork Standards, Section 2.
- B. Store woodwork in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.
 - 1. Handle and store fire-retardant-treated wood to comply with chemical-treatment manufacturer's written instructions.

1.8 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation of woodwork only when existing and forecasted weather conditions permit work to be sufficiently completed to ensure no damage to any part of the existing building.
- 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.
 - 1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being concealed by construction, and indicate measurements on Shop Drawings.
- C. Established Dimensions: Where woodwork is indicated to fit to other construction, establish dimensions for areas where woodwork is to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of carpentry work indicated for construction, finishes, installation, and other requirements.
 - 1. The Contract Documents contain requirements that are more stringent than the Architectural Woodwork Standards. Comply with Contract Documents and the Architectural Woodwork Standards.

2.2 PRESERVATIVE-TREATED-WOOD MATERIALS

- A. Preservative-Treated-Wood Materials: Provide with water-repellent preservative treatment complying with AWWA N1 (dip, spray, flood, or vacuum-pressure treatment).

1. Preservative Chemicals: 3-iodo-2-propynyl butyl carbamate (IPBC), combined with a compatible EPA-registered insecticide.
 2. Use chemical formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants in solution to distinguish treated material from untreated material.
- B. Extent of Preservative-Treated Wood Materials: Treat wood materials except items indicated to be fire-retardant treated.
1. Items fabricated from the following wood species need not be treated:
 - a. All-heart redwood.
 - b. All-heart western red cedar.
 - c. White oak.
 - d. African mahogany.
 - e. Honduras mahogany.
 - f. Ipe.
 - g. Dark red meranti.
 - h. Teak.

2.3 FIRE-RETARDANT-TREATED WOOD MATERIALS

- A. Fire-Retardant-Treated Wood Materials, General: Where fire-retardant-treated materials are indicated, use materials complying with requirements that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products according to test method indicated by a qualified testing agency.
1. Use treated materials that comply with requirements of the Architectural Woodwork Standards for the grade specified. 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. Exterior Fire-Retardant-Treated Lumber and Plywood: Products with a flame-spread index of 25 or less when tested according to ASTM E84 after being subjected to

accelerated weathering according to ASTM D2898, 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. 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.
3. Mill lumber before treatment and implement 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.

C. Extent of Fire-Retardant-Treated Wood Materials:

1. Exterior carpentry work located more than 40 feet above grade.
2. Exterior carpentry work in locations with a fire-separation distance of 5 feet or less.
3. Where indicated on Drawings.

2.4 MISCELLANEOUS ROUGH CARPENTRY MATERIALS

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
1. Factory mark each piece of lumber with grade stamp of grading agency.
 2. Provide dressed lumber, S4S, unless otherwise indicated.
 3. Either preservative treated or fire-retardant treated.
- B. Maximum Moisture Content of Lumber: 15 percent for 2-inch nominal thickness or less, 19 percent for more than 2-inch nominal thickness unless otherwise indicated after treatment.
- C. Plywood: Provide sanded $\frac{3}{4}$ in minimum thickness APA A-C, Group 1, Exterior or Exposure 1, structural plywood panels performance-rated pursuant to National Institute of Standards and Technology (NIST) voluntary product standard PS-1-95; identified with American Plywood Association (APA) grade designations.
1. Oriented strand board (OSB) is not allowed.
- D. Treatment: Un-treated wood not allowed for miscellaneous rough carpentry. Treat all items as either preservative treated or fire-retardant treated as indicated above.

2.5 EXTERIOR FINISH CARPENTRY

- A. Architectural Woodwork Standards Grade: Premium.
- B. Backout or groove backs of flat trim members, and kerf backs of other wide, flat members, except for members with ends exposed in finished work.
- C. Lumber Trim: Select from the following:
 - 1. Species and Grade: Redwood; RIS Clear.
 - 2. Species and Grade: Western red cedar; NLGA, WCLIB, or WWPA Grade A.
 - 3. Species and Grade: Hem-fir; NLGA, WCLIB, or WWPA Prime or D finish.
 - 4. Species and Grade: Eastern white pine, eastern hemlock-balsam fir-tamarack, eastern spruce, or white woods; NeLMA, NLGA, WCLIB, or WWPA D Select (Quality).
 - 5. Species and Grade: Northern white cedar; NeLMA or NLGA D Select.
 - 6. Maximum Moisture Content: 15 percent with at least 85 percent of shipment at 12 percent or less].
 - 7. Finger Jointing: Not allowed.
 - 8. Face Surface: Surfaced (smooth).
 - 9. Factory Priming: Factory coated on both faces and all edges, with exterior primer compatible with topcoats specified.
- D. Moldings: MMPA WM 4, P-grade wood moldings, made from kiln-dried stock to patterns included in MMPA's "WM/Series Softwood Moulding Patterns."
 - 1. Species: As listed for lumber trim.
 - 2. Finger Jointing: Not allowed.
 - 3. Factory Priming: Factory coated on both faces and all edges, with exterior primer compatible with topcoats specified.

2.6 FASTENERS

- A. General: Provide fasteners of size and type indicated, acceptable to authorities having jurisdiction, and that comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than 1-1/2 inches into wood substrate.
 - 1. Use stainless steel fasteners for all work unless otherwise indicated.
- B. Nails: ASTM F1667.
- C. Power-Driven Fasteners: ICC-ES AC70.
- D. Wood Screws and Lag Screws: ASME B18.2.1, ASME B18.6.1, or ICC-ES AC233.

- E. Stainless-Steel Bolts: ASTM F593, Alloy Group 1 or 2; with ASTM F594, Alloy Group 1 or 2 hex nuts and, where indicated, flat washers.
- F. Postinstalled Anchors: Stainless-steel, [chemical] [or] [torque-controlled expansion] anchors with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing according to ASTM E488/E488M conducted by a qualified independent testing and inspecting agency.
 - 1. Stainless-steel bolts and nuts complying with ASTM F593 and ASTM F594, Alloy Group 1 or 2.
 - 2. Fastener systems shall have an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01, ICC-ES AC58, ICC-ES AC193 or ICC-ES AC308 as appropriate for the substrate.
- G. Fasteners for Exterior Finish Carpentry: Provide nails or screws, in sufficient length to penetrate not less than 1-1/2 inches into wood substrate.
 - 1. For face-fastening siding, provide ringed-shank siding nails.
- H. Fasteners/anchors for blocking assembly at copings shall be selected using ICC ES reports for the following minimum loading applied in any direction.
 - 1. Anchors into structural steel: 300 lbs with a safety of 2
 - 2. Anchor into cold formed metal framing: 300 lbs with a safety factor of 3.
 - 3. Anchors into Concrete: 300 lbs with a safety factor of 3
 - 4. Anchors into fully grouted CMU and bond beams: 300 lbs with a safety factor of 4

2.7 ACCESSORIES

- A. Wood Glue: Waterproof glue recommended by manufacturer for exterior carpentry use.
- B. Construction Adhesive: Compliant with ASTM D3498 and APA AFG-01.
- C. Flashing: Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim" for flashing materials installed in exterior finish carpentry.
- D. Epoxy Wood Patching Materials
 - 1. Wood Pretreatment: Ready-to-use product designed for hardening and sealing soft fibers of wood materials that have deteriorated due to weathering and exposure and designed specifically to enhance the bond of wood patching compound to existing wood.
 - a. Available Products:

- 1) Abatron, Inc.; Liquidwood.
 - 2) Advanced Repair Technology; Primatrate.
 - 3) Wood Care Systems; Liquid TIMBR.
2. Wood Patching Compound: 2-part epoxy-resin wood compound with a 10- to 15-minute cure at 70 deg F, in knife grade formulation and recommended by manufacturer for type of wood repair indicated. Compound shall be designed for filling damaged wood materials that have deteriorated due to weathering and exposure. Compound shall be capable of filling deep holes and capable of spreading to feather edge.
- a. Available Products:
- 1) Abatron, Inc.; Liquidwood with WoodEpoxy.
 - 2) Advanced Repair Technology; Primatrate with Flex-Tec HV.
 - 3) Gougeon Brothers, Inc.; West System.
 - 4) Polymeric Systems Inc.; Quickwood.
 - 5) Wood Care Systems; Liquid TIMBR with TIMBR Flex.
- E. Sealants: Specified in Section 079205 "Exterior Joint Sealants," and recommended by sealant and substrate manufacturers for intended application.

2.8 FABRICATION

- A. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.
- B. Fabricate exterior architectural woodwork to dimensions, profiles, and details indicated.
1. Ease edges to radius indicated for the following:
- a. Edges of Solid-Wood (Lumber) Members: 1/16 inch unless otherwise indicated.
- C. Complete fabrication, including assembly, to maximum extent possible before shipment to Project site.
1. Disassemble components only as necessary for shipment and installation.
 2. Where necessary for fitting at site, provide allowance for scribing, trimming, and fitting.
 3. Notify Architect seven days in advance of the dates and times exterior architectural woodwork fabrication will be complete.
 4. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled.
- a. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting.

- b. Verify that parts fit as intended, and check measurements of assemblies against field measurements indicated on approved Shop Drawings before disassembling for shipment.

2.9 SHOP PRIMING

- A. Preparations for Finishing: Comply with the Architectural Woodwork Standards for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing exterior architectural woodwork, as applicable to each unit of work.
- B. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to surfaces installed in contact with concrete or masonry and to end-grain surfaces.
- C. Exterior Carpentry Work for Opaque Finish: Shop prime all surfaces (6 sides) of new materials with one coat of wood primer.
 - 1. Primer, Alkyd for Exterior Wood, MPI #5

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition exterior architectural woodwork to average prevailing humidity conditions at Project site.
- B. Before installing exterior architectural woodwork, examine shop-fabricated work for completion, and complete work as required, including removing packing and backpriming concealed surfaces.

3.2 INSTALLATION

- A. Grade: Install exterior architectural woodwork to comply with same grade as item to be installed.
- B. Assemble exterior architectural woodwork, and complete fabrication at Project site to the extent that it was not completed during shop fabrication.
- C. Install exterior architectural woodwork level, plumb, true in line, and without distortion.
 - 1. Shim as required with concealed shims.
 - 2. Install level and plumb to a tolerance of 1/8 inch in 96 inches.
- D. Miscellaneous Framing and Blocking

1. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit.
2. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
3. Do not splice structural members between supports unless otherwise indicated.
4. Comply with AWP4 M4 for applying field treatment to cut surfaces of preservative-treated lumber.
5. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - a. NES NER-272 for power-driven fasteners.
 - b. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.

E. Dutchman Repairs: Repair localized damaged wood using dutchman.

1. Cut out defective wood. Remove defective wood a minimum 1/4" past the apparent area of deterioration. Whenever possible, create voids that will provide mechanical attachments, e.g. dovetails. Cut an irregular geometrically-shaped cavity in the wood that is slightly larger than the damaged area. Select a geometric shape that is easy to reproduce such as a diamond or trapezoid with edges that are generally not parallel to the edges of the piece being patched.
2. Fabricate a plug from matching wood stock to match the surface cavity bevel. Make sure that the grain direction matches. Cut dutchman to fill void and to project past exposed faces of repair area.
3. Dry-fit joints to ensure that joints are tight. Clean glue surfaces according to glue manufacturer's written instructions. Apply glue, set dutchman and clamp until glue has set.
4. Allow the glue to dry, then plane or sand if necessary and refinish to match surrounding wood.
5. Where Dutchman is adjacent to a joint fabricate to replicate existing joinery.

F. Patching with Epoxy

1. Patch wood members that have been damaged and exhibit depressions, holes, or similar voids, and that have limited rotted or decayed wood. Remove rotted or decayed wood down to sound wood.
 - a. Treat wood members with wood pretreatment prior to application of patching compound according to repair and patching material manufacturer's written instructions.
2. Apply patching compound to fill depressions, nicks, cracks, and other voids. Apply compound in layers as recommended by manufacturer until the void is completely filled. Sand patching compound smooth and flush, matching contour of existing wood member.
3. Clean spilled compound from adjacent materials immediately.

G. Standing and Running Trim:

1. Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible.
2. Do not use pieces less than 96 inches long, except where shorter single-length pieces are necessary.
3. Scarf running joints and stagger in adjacent and related members.

H. Scribe and cut exterior architectural woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

I. Preservative-Treated Wood Materials: Where field cut or drilled, treat cut ends and drilled holes according to AWP4 M4.

J. Fire-Retardant-Treated Wood Materials: Install fire-retardant-treated materials to comply with chemical treatment manufacturer's written instructions.

K. Anchor exterior architectural woodwork to anchors or blocking built in or directly attached to substrates.

1. Secure with countersunk, concealed fasteners and blind nailing.
2. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with exterior architectural woodwork.
3. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced and with adjacent rows staggered.
4. For shop-finished items, use filler matching finish of items being installed.

L. Installation of Standing and Running Trim:

1. Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible.
2. Do not use pieces less than 96 inches long, except where shorter single-length pieces are necessary.
3. Scarf running joints and stagger in adjacent and related members.

M. Field Finishing: See Section 090190 "Exterior Maintenance Painting" for final finishing of installed exterior architectural woodwork.

3.3 REPAIR

A. Repair damaged and defective exterior architectural woodwork, where possible, to eliminate functional and visual defects and to result in exterior architectural woodwork being in compliance with requirements of the Architectural Woodwork Standards for the specified grade.

B. Where not possible to repair, replace defective woodwork.

3.4 CLEANING

- A. Clean exterior architectural woodwork on exposed and semiexposed surfaces.

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SECTION 06 10 53

MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Framing with dimension lumber.
2. Rooftop equipment wood bases and support curbs.
3. Rooftop wood blocking and nailers.
4. Wood Interior concealed wood blocking and nailers.
5. Wood sleepers.
6. Utility shelving.
7. Plywood backing panels.

1.2 DEFINITIONS

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

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product.
1. Indicate component materials and dimensions and include construction and application details.
 2. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
 3. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
 4. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.

5. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
6. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

1.4 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For the following, from ICC-ES:

1. Preservative-treated wood.
2. Fire-retardant-treated wood.
3. Power-driven fasteners.
4. Powder-actuated fasteners.
5. Expansion anchors.
6. Metal framing anchors.

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. Composite Wood Products: Made with no added urea formaldehyde.
- B. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
1. Factory mark each piece of lumber with grade stamp of grading agency.
 2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece.
 3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
 4. Provide dressed lumber, S4S, unless otherwise indicated.
- C. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment by Pressure Process: AWP A 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. ACQ Preservative: Water-borne ammoniacal copper quat (ACQ) preservative.
 - 2. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
 - 3. 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 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.
- D. Application: Treat items indicated on Drawings, and the following:
 - 1. Wood nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 - 2. Wood plates, sills, sleepers, blocking, and similar concealed members in direct contact with masonry or concrete.
 - 3. Wood framing members that are less than 18 inches (460 mm) above the ground in crawl spaces or unexcavated areas.
 - 4. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. General: 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 and smoke developed rating of 450 or less when tested according to ASTM E 84, 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 (3.2 m) 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 D 2898. Use for exterior locations.
 - 3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.

- C. Kiln-dry lumber after treatment.
 - 1. Lumber: 19 percent maximum moisture content of 19 percent.
 - 2. Plywood: Kiln-dry plywood after treatment to a 15 percent maximum moisture content.
- D. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece.
- E. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.
- F. Application: Treat all miscellaneous carpentry unless otherwise indicated.

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. Grounds.
 - 5. Utility shelving.
- B. For utility shelving, provide lumber with 15 percent maximum moisture content and any of the following species and grades:
 - 1. Eastern white pine, Idaho white, lodgepole, ponderosa, or sugar pine; Premium or No. 2 Common Sterling and Standard or No. 3 Common grade; NeLMA, NLGA, WCLIB, or WWP.
 - 2. Mixed southern pine, No. 1 grade; SPIB.
 - 3. Hem-fir or hem-fir north, Select Merchantable or No. 1 Common grade; NLGA, WCLIB, or WWP.
 - 4. Spruce-pine-fir south or spruce-pine-fir, Select Merchantable or No. 1 Common grade; NeLMA, NLGA, WCLIB, or WWP.
- C. For concealed boards, provide lumber with 19 percent maximum moisture content and any of the following species and grades:
 - 1. Mixed southern pine, No. 2 grade; SPIB.
 - 2. Hem-fir or hem-fir (north), Construction or No. 2 Common grade; NLGA, WCLIB, or WWP.
 - 3. Spruce-pine-fir (south) or spruce-pine-fir, Construction or No. 2 Common grade; NeLMA, NLGA, WCLIB, or WWP.
 - 4. Eastern softwoods, No. 2 Common grade; NELMA.
 - 5. Northern species, No. 2 Common grade; NLGA.
 - 6. Western woods, Construction or No. 2 Common grade; WCLIB or WWP.

- D. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- E. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.5 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: DOC PS 1, Exterior, C-C Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 1/2-inch (13-mm) nominal thickness.

2.6 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. ACQ Preservative Treated Wood: Type 304 stainless steel.
 - 2. Other Applications: ASTM A 153/A 153M hot-dip galvanized.
 - 3. All Applications: ASTM A 153/A 153M hot-dip galvanized.
 - 4. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Power-Driven Fasteners: NES NER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Screws for Fastening to Metal Framing: ASTM C 1002 and ASTM C 954, length as recommended by screw manufacturer for material being fastened.
 - 1. Cold-Formed Metal Framing: ASTM C 954.
 - 2. Other Metal Framing: ASTM C 1002.
- F. Lag Bolts: ASME B18.2.1/ASME B18.2.3.8M.
- G. Bolts: Steel bolts complying with ASTM A 307, Grade A ASTM F 568M, Property Class 4.6; with ASTM A 563/ASTM A 563M hex nuts and, flat washers.
- H. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
 - 1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
 - 2. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2: ASTM F 738M and ASTM F 836M, Grade A1 or A4.

2.7 METAL FRAMING ANCHORS

- A. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 Z180 coating designation.
 - 1. Use for interior locations unless otherwise indicated.
- B. Hot-Dip Heavy-Galvanized Steel Sheet: ASTM A 653/A 653M; Structural Steel, high-strength low-alloy steel Type A, HSLAS Type A, or high-strength low-alloy steel Type B/HSLAS Type B; G185, Z550 coating designation; and not less than 0.036 inch (0.9 mm) thick.
 - 1. Use for wood-preservative-treated lumber.
- C. Stainless-Steel Sheet: ASTM A 666, Type 304.
 - 1. Use for exterior locations.

2.8 MISCELLANEOUS MATERIALS

- A. Adhesives for Gluing Furring to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.
 - 1. Adhesives shall have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D, EPA Method 24.
- B. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch (0.6 mm).

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, and similar carpentry supports to comply with requirements for attaching other construction.
- B. Where ACQ wood-preservative-treated lumber is installed adjacent attached to metal decking, install continuous flexible flashing separator between wood and metal decking.
- C. Where lumber without preservative treatment is attached to concrete or masonry, install continuous flexible flashing separator between wood and substrate.
- D. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- E. Install plywood backing panels by fastening to studs with fire retardant classification marking exposed to view; coordinate locations with utilities requiring backing panels. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.

- F. Metal Framing Anchors: Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.
- G. Do not splice structural members between supports unless otherwise indicated.
- H. Provide blocking and framing as required to support facing materials, fixtures, specialty items, and trim.
 - 1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406 mm) o.c.
- I. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as follows:
 - 1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches (2438 mm) o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
 - 2. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches (2438 mm) o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal (38-mm actual) thickness.
 - 3. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 sq. ft. (9.3 sq. m) and to solidly fill space below partitions.
 - 4. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet (6 m) o.c.
- J. 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.
- K. Securely attach carpentry work to substrate by anchoring and fastening, complying with the following:
 - 1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
- L. 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 required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.
- C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches (38 mm) wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.3 PROTECTION

- A. Protect wood that has been treated with inorganic boron, SBX, from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
- B. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION

NOT FOR BID

SECTION 06 10 73

EXTERIOR MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Miscellaneous Rough Carpentry for use on the exterior of the building.
 - 1. Built-up plywood box sections at copings.
 - 2. Blocking indicated in roofing.
 - 3. Wood blocking, furring and nailers related to the exterior enclosure.
- B. Related Requirements:
 - 1. Section 01 45 25 "Exterior Enclosure Testing Services"
 - 2. Section 01 83 16 "Exterior Enclosure General Requirements" for additional requirements related to the building enclosure including but not limited to:
 - a. Performance and design requirements for the exterior building enclosure.
 - b. Coordination of Work required to complete the Exterior Enclosure.
 - c. Quality Assurance and Control procedures required for the work of the Exterior Enclosure.
 - 3. Division 02 Section 02 41 16– "Selective Demolition" for temporary barriers supports and shoring of walls and ceilings to remain.
 - 4. Section 06 40 13 – "Exterior Architectural Woodwork" for wood products exposed in the finished work.
 - 5. Division 06 10 53 Section – "Rough Carpentry" for similar work on the interior of the building.

1.2 ACTION SUBMITTALS

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

Include physical properties of treated materials based on testing by a qualified independent testing agency.

3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
5. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

1.3 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For the following, from ICC-ES:

1. Preservative-treated wood.
2. Fire-retardant-treated wood.
3. Power-driven fasteners.
4. Post-installed anchors.
5. Expansion anchors.

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.

A. Sustainable Qualifications

1. Sustainable design: Certificate for manufacturer qualifications.
2. Sustainable design: Certificate for vendor qualifications

1.5 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. Sustainability Design

1. Regional Material for Wood Products: Product documentation indicating distance to project site, cost for each regional material and fraction by weight that is considered regional.
- B. Certified Wood: Lumber shall be produced from wood obtained from forests certified by an FSC-accredited certification (Forest Stewardship Council) body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
 1. Provide purchase order indicating FSC certificate number of vendor, line itemized list of contributing material with chain-of –custody number and material cost.
- C. Composite Wood and Agrifiber: Provide documentation indicating compliance with California Air Resources Board ATCM for formaldehyde requirements for ultra-low-emitting formaldehyde (ULEF) resins or no added formaldehyde resins.
- D. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
 1. Factory mark each piece of lumber with grade stamp of grading agency.
 2. Provide dressed lumber, S4S, unless otherwise indicated.
- E. Maximum Moisture Content of Lumber: 15 percent for 2-inch nominal thickness or less, 19 percent for more than 2-inch nominal thickness unless otherwise indicated.
- F. Plywood: Provide sanded $\frac{3}{4}$ in minimum thickness APA A-C, Group 1, Exterior or Exposure 1, structural panels performance-rated pursuant to National Institute of Standards and Technology (NIST) voluntary product standard PS-1-95; identified with American Plywood Association (APA) grade designations.
 1. Oriented strand board (OSB) is not allowed.
- G. Application: Un-treated wood not allowed. Treat all items as either preservative treated or fire-retardant treated as indicated below.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment by Pressure Process: AWPA 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.

- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
- D. Application: Treat wood copings, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing.

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E 84, 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. 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 D 2898. Use for exterior locations and where indicated.
- B. 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.
- C. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
- D. Application: Treat all miscellaneous carpentry unless otherwise indicated for wood preservative treatment.

2.4 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, either fire-retardant treated, or preservative treated for application, including the following:
 - 1. Blocking.
 - 2. Nailers.
 - 3. Cants.
 - 4. Furring.
- B. For items of dimension lumber size, provide Construction or No. 2 grade lumber of any species.

2.5 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. Provide fasteners of Type 304 stainless steel.
- B. Power-Driven Fasteners: NES NER-272 for use at structural steel only.
- C. Screws for Fastening to Metal Framing: ASTM C 954, length as recommended by screw manufacturer for material being fastened.
- D. Screws for Fastening Wood to Wood: Code approved stainless steel structural screws, minimum #10, with length necessary for minimum 1" engagement when attaching plywood to framing and 2" engagement when attaching framing members.
- E. Fasteners/anchors for blocking assembly at copings shall be selected using ICC ES reports for the following minimum loading applied in any direction.
 - 1. Anchors into structural steel: 300 lbs with a safety of 2
 - 2. Anchor into cold formed metal framing: 300 lbs with a safety factor of 3.
 - 3. Anchors into Concrete: 300 lbs with a safety factor of 3
 - 4. Anchors into fully grouted CMU and bond beams: 300 lbs with a safety factor of 4
- F. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01, ICC-ES AC58, ICC-ES AC193 or ICC-ES AC308 as appropriate for the substrate.
- G. Construction Adhesive: Compliant with ASTM D3498 and APA AFG-01.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit.
- A. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- B. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- C. Built-up plywood box sections at copings and where indicated. Use multiple layers of minimum $\frac{3}{4}$ " plywood with dimensional lumber at edges and across width at 2'-0" on-center to provide indicated slope.

1. Rip dimensional lumber to height and slope and anchor to CFMF
 2. Install plywood with "A" side up, edges supported by blocking or structural framing, fastened using only non-corrosive screw fasteners with heads installed flush with sheathing applied at 6 in minimum o.c. along panel edges and 8 in o.c. over intermediate supports and/or additional fastening as required by jurisdictional codes.
- D. Do not splice structural members between supports unless otherwise indicated.
- E. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
- F. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
1. NES NER-272 for power-driven fasteners.
 2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.

END OF SECTION

NOT FOR BID

SECTION 06 40 23

INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
1. Judges Benches, Witness Boxes, Clerk Stations, Attorney Tables, Spectator Rail, Spectator Pew, Public Counter, Security Desk, Courtroom Entryways, Rails and other items indicated on Drawings.
 2. Interior standing and running trim.
 3. Wood handrails.
 4. Other millwork items noted on the Drawings.
 5. Hardware and attachment accessories.
 6. Wood furring, blocking, shims, and hanging strips for installing woodwork items unless concealed within other construction before woodwork installation.
 7. Shop finishing of interior woodwork.

1.2 PREINSTALLATION CONFERENCE

- A. Preinstallation Conference: Review requirements, coordination with building services, provisions for attachment to the building floor slabs, etc.
- B. Coordination for appropriate work sequence and compliance with Project schedule for shop fabrication and field installation work as required.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated, including cabinet hardware and accessories and finishing materials and processes.
- B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
1. Show details full size.
 2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
 3. Show locations and sizes of cutouts and holes for plumbing fixtures, faucets, electrical switches and outlets, and other items installed in architectural woodwork.
 4. Show hardware attachment.
 5. For paneling produced from premanufactured sets, show finished panel sizes, set numbers, sequence numbers within sets, and method of cutting panels to produce indicated sizes.
 6. Apply AWI Quality Certification Program label to Shop Drawings.

C. Samples for Initial Selection:

1. Shop-applied transparent finishes.

D. Samples for Verification:

1. Provide 3 samples of lumber with or for transparent finish, not less than 5 inches wide by 24 inches long, for each species and cut, finished on 1 side and 1 edge.
2. Provide 2 samples for each species and cut of lumber and panel products with non-factory-applied finish, with 1/2 of exposed surface finished, 50 sq. in. for lumber and 8 by 10 inches for panels.
3. Veneer leaves representative of and selected from flitches to be used for transparent-finished woodwork.
4. Veneer-faced panel products with or for transparent finish, 12 by 24 inches, for each species and cut. Include at least one face-veneer seam and finish as specified.
5. Corner pieces as follows:
 - a. Cabinet-front frame joints between stiles and rails, as well as exposed end pieces, 18 inches high by 18 inches wide by 6 inches deep.
 - b. For stile and rail paneling, 18 inches high by 18 inches wide by 6 inches deep.
 - c. Miter joints for standing trim.
6. Exposed cabinet hardware and accessories, one unit for each type and finish.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and fabricator.
- B. Product Certificates: For each type of product.
- C. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.
- D. Sample Warranty: For manufacturer warranty.

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 with minimum five years documented experience.
- C. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of woodworks indicated for construction, finishes, installation, and other requirements.
 1. Provide labels and certificates from AWI certification program indicating that woodwork, including installation, complies with requirements of grades specified.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.
- B. Stack lumber, plywood, and other panels flat with spacers between each bundle to provide air circulation. Protect materials from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Do not install woodwork materials that are wet, moisture damaged, or mold damaged.
 - 1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.
- C. 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.

1.8 COORDINATION

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

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Provide materials that comply with requirements of AWI's quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.
- B. Wood Products: Comply with the following:
 - 1. Lumber: DOC PS 20.

- a. Factory mark each piece of lumber with grade stamp of inspection agency indicating grade, species, moisture content at time of surfacing, and mill.
 - 1) For exposed lumber, mark grade stamp on end or back of each piece, or omit grade stamp and provide certificates of grade compliance issued by inspection agency.
- 2. Softwood Plywood: DOC PS 1.
- 3. Hardboard: AHA A135.4.
- 4. MDF: ANSI A208.2, Grade 130, made with binder containing no urea formaldehyde.
- C. Plywood: nominal 0.75 inch minimum thickness unless otherwise approved.
- D. Veneer Species, Cut, and Matching: As indicated in the Finish Legend on the Drawings.
- E. Medium Density Fiberboard, MDF: ANSI A208.2, Grade 150, MR30 except MR50 for fabrications having proximity to sink and similar source of water or liquid; 0.75 inch thick unless otherwise indicated; formaldehyde free.
 - 1. Medex by SierraPine.

2.2 HARDWARE AND ACCESSORIES

- A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets, except for items specified in Division 08 Section 08 71 00, "Door Hardware."
- B. Frameless Concealed Hinges, European Type: BHMA A156.9, B01602, 100 degrees of opening, self-closing.
- C. Jury Box Gate Hinge: Pivot hinge, removable, Concealed Floor Closers assembly, Rixon Model Q51 satin nickel or approved.
- D. Spectator Gate Hinges: Self-closing, spring-concealed hinge assembly, Soss Model 212 or 220 as required for assembly, satin nickel finish or approved.
- E. Folding Bracket for AV Lectern: Provide EB Series folding bracket by SUGATSUNE to provide support at AV Lectern shelf.
- F. Hinge: Provide noise reduction hinge on gate at judge's bench in Courtroom as indicated on Drawings.
 - 1. Product: Subject to compliance with requirements provide Model 220 Invisible hinge by SOSS Door Hardware.
 - 2. Finish: Satin chrome.
- G. Reveals: Material as selected by Architect, 1/4 inch.
- H. Back-Mounted Pulls: BHMA A156.9, B02011.
- I. Catches: Magnetic catches, BHMA A156.9, B03141.
- J. Adjustable Shelf Standards and Supports: BHMA A156.9, B04071; with shelf rests, B04081.

- K. Drawer Slides: BHMA A156.9.
 - 1. Standard Duty Grade 1, Grade 2, and Grade 3: Side mounted; full-extension type; epoxy-coated steel with polymer rollers.
 - 2. Keyboard Slides: Grade 1HD-100; for computer keyboard shelves.
- L. Door and Drawer Silencers: BHMA A156.16, L03011.
- M. Grommets for Cable Passage through Countertops: 1-1/4-inch OD, color as selected by Architect, molded-plastic grommets and matching plastic caps with slot for wire passage.
- N. Supports: For counter or similar surface not supported by base cabinet or legs provide one pair of supports for first 48 inches in length and one additional support for every 2 lineal feet, or increment exceeding 48 inches and as otherwise necessary for support of surface in configuration required without exceeding supports rated weight capacity.
 - 1. Hafele Hebgo bracket 287.45 series.
- O. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
 - 1. Satin Chromium Plated: BHMA 626 for brass or bronze base; BHMA 652 for steel base.
- P. For concealed hardware, provide manufacturer standard finish that complies with product class requirements in BHMA A156.9.

2.3 CUSTOM WOOD PANELING

- A. Provide concealed fastening attachments.
- B. Provide hinged, removable panels for locations indicated secured by concealed catch or other acceptable device.
- C. Balance Backing: Straight-grained hardwood of the same thickness and grain orientation as the face veneer or approved balanced backing.
- D. Battens: Profile, spacing and pattern as indicated on A650 series sheets and elsewhere on the drawings.
 - 1. Coordinate openings and removable panels with requirements for ventilation at mechanical diffuser.

2.4 CUSTOM BENCH AND PEW

- A. Laminated construction of solid stock hardwood in configuration indicated using Type I waterproof glue. Comply with AWS Section 6 for Premium Grade work.

2.5 INTERIOR TRIM

A. Lumber Trim for Opaque Painted Finish:

1. Species and Grade: As indicated in Finish Schedule on Drawings; A Finish; NHLA.
2. Maximum Moisture Content: 9 percent.
3. Finger Jointing: Not allowed.
4. Face Surface: Surfaced smooth.

B. Moldings for Opaque Painted Finish: Made to patterns included in WMMPA WM 12.

1. Hardwood Moldings: WMMPA HWM 2, P-grade.
 - a. Species: Aspen, basswood, cottonwood, gum, magnolia, soft maple, tupelo, or yellow poplar.
 - b. Maximum Moisture Content: 9 percent.
2. Optional Material: Primed MDF.
3. Finger Jointing: Not allowed.
4. Trim Pattern: As indicated on Drawings.

2.6 HANDRAILS

A. Grade: Custom.

B. Handrails:

1. Species and Finish: As selected by Architect.
2. Size and Configuration as indicated on Drawings.

2.7 CUSTOM TABLE

A. Custom assembly as indicated on Drawings of veneer and solid stock fabrications with metal components and end screen panel as indicated.

1. Table Top: Solid sock laminated assembly using members of uniform length and dimension; random length members and butcher-block type assembly are not acceptable.
2. Table Supports: Veneer faced plywood and solid stock fabrication as indicated and as necessary for attachment to supporting building structure.
3. Table Legs: Hollow legs allowing passage of power cords and other cables as required, with grommets at table top.

2.8 MISCELLANEOUS MATERIALS

A. Cementitious Board: Refer to Section 09 29 00, "Gypsum Board."

B. Ballistic-Rated Fiberglass Panels: Refer to Section 09 29 00, "Gypsum Board."

1. Size: As indicated on Drawings.

- C. Interior Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.
- D. Provide self-drilling screws for metal-framing supports, as recommended by metal-framing manufacturer.
- E. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.
- F. Fasteners: Nails, screws, and other anchoring devices of type, size, material, and finish required for application indicated to provide secure attachment, galvanized finish in concealed location. Comply with applicable requirements of ASTM A 307 for screws and ASTM F 1667 for nails.
- G. Multipurpose Construction Adhesive: Formulation complying with ASTM D 3498 that is recommended for indicated use by adhesive manufacturer.
- H. Adhesive: Urea-formaldehyde free, water resistant and suitable for the type of material and substrate to be bonded; shall not telegraph through finish materials.
- I. Concealed Joint Fasteners: Threaded steel.
- J. Wood filler: Solvent base, tinted to match surface finish color.
- K. Primer: As specified in Division 09 Section 09 90 00, "Painting and Coatings."

2.9 FABRICATION, GENERAL

- A. Interior Woodwork Grade: Unless otherwise indicated, provide Custom-grade interior woodwork complying with referenced quality standard.
- B. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.
- C. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:
 - 1. Edges of Solid-Wood Members: 1/16 inch unless otherwise indicated.
 - 2. Corners of Cabinets and Edges of Solid-Wood Members 3/4 inch thick or Less: 1/16 inch.
 - 3. Edges of Rails and Similar Members More Than 3/4 Inch Thick: 1/16 inch.
 - 4. Corners of Cabinets and Edges of Solid-Wood Members and Rails: 1/16 inch.
- D. 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.
- E. Arrange paneling in shop or other suitable space in proposed sequence for examination by Architect. Mark units with temporary sequence numbers to indicate position in proposed layout.
 - 1. Lay out one elevation at a time if approved by Architect.

2. Notify Architect seven days in advance of the date and time when layout will be available for viewing.
 3. Provide lighting of similar type and level as that of final installation for viewing layout, unless otherwise approved by Architect.
 4. Rearrange paneling as directed by Architect until layout is approved.
 5. Do not trim end units and other nonmodular size units to less than modular size until after Architect's approval of layout. Indicate trimming by masking edges of units with nonmarking material.
 6. Obtain Architect's approval of layout before start of assembly. Mark units and Shop Drawings with assembly sequence numbers based on approved layout.
- F. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
1. Notify Architect seven days in advance of the dates and times woodwork fabrication will be complete.
- G. Shop-cut openings to maximum extent possible to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
1. Seal edges of openings in countertops with a coat of varnish.

2.10 FABRICATION OF INTERIOR TRIM

- A. Back out or kerf backs of the following members except those with ends exposed in finished work:
1. Interior standing and running trim except shoe and crown molds.
- B. Ease edges of lumber less than 1 inch in nominal thickness to 1/16-inch radius and edges of lumber 1 inch or more in nominal thickness to 1/8-inch radius.

2.11 WOOD CABINETS FOR TRANSPARENT FINISH

- A. Grade: Custom.
- B. Wood for Exposed Surfaces:
1. Species and Cut: As indicated on Drawings.
 2. Grain Direction: As indicated.
 3. Matching of Veneer Leaves: Book match.
 4. Veneer Matching within Panel Face: Balance match.
- C. Semiexposed Surfaces: Provide surface materials indicated below:
1. Surfaces Other Than Drawer Bodies: Same species and cut indicated for exposed surfaces.

- a. Edges of Thermoset Decorative Panel Shelves: PVC or polyester edge banding.
- 2. Drawer Sides and Backs: Thermoset decorative panels with PVC or polyester edge banding.
- 3. Drawer Bottoms: Thermoset decorative panels.
- D. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.
 - 1. Join subfronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners or glued dovetail joints.

2.12 PLASTIC-LAMINATE CABINETS

- A. Grade: Custom.
- B. Cabinet Construction: As indicated.
- C. Door and Drawer Front Style: Reveal overlay.
- D. Reveal Dimension: As indicated.
- E. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by woodwork quality standard.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Formica Corporation, as basis of design.
 - b. Abet Laminati, Inc.
 - c. Lamin-Art, Inc.
 - d. Panolam Industries International, Inc.
 - e. Wilsonart International; Div. of Premark International, Inc.
- F. Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate complying with the following requirements:
 - 1. Horizontal Surfaces Other Than Tops: Grade HGS.
 - 2. Postformed Surfaces: Grade HGP.
 - 3. Vertical Surfaces: Grade VGS.
 - 4. Edges: Grade HGS.
- G. Materials for Semiexposed Surfaces:
 - 1. Surfaces Other Than Drawer Bodies: Thermoset decorative panels.
 - a. Edges of Plastic-Laminate Shelves: PVC tape, 0.018-inch minimum thickness, matching laminate in color, pattern, and finish.
 - 2. Drawer Sides and Backs: Thermoset decorative panels.
 - 3. Drawer Bottoms: Thermoset decorative panels.

- H. Concealed Backs of Panels with Exposed Plastic Laminate Surfaces: High-pressure decorative laminate, Grade BKL.
- I. Colors, Patterns, and Finishes: As indicated in the Finish Legend on Drawings.
- J. Provide dust panels of 1/4-inch plywood or tempered hardboard above compartments and drawers, unless located directly under tops.

2.13 COUNTERTOPS

- A. As specified in Section 12 36 00 "Countertops."

2.14 SHOP FINISHING

- A. Grade: Provide finishes of same grades as items to be finished.
- B. General: Finish architectural woodwork at fabrication shop as specified in this Section. Sand work smooth and set exposed nails and screws. Defer only final touchup, cleaning, and polishing until after installation.
- C. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural woodwork, as applicable to each unit of work.
 - 1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to back of paneling and to end-grain surfaces. Concealed surfaces of plastic-laminate-clad woodwork do not require backpriming when surfaced with plastic laminate, backing paper, or thermoset decorative panels.
- D. Transparent Finish:
 - 1. Grade: Custom.
 - 2. Finish: System - 11, catalyzed polyurethane.
 - 3. Staining: Color to match existing finish and as approved by Architect for items indicated on Drawings and approved test samples as specified.
 - 4. Sheen: Satin, 31-45 gloss units measured on 60-degree gloss meter per ASTM D 523.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

- A. Grade: Install woodwork to comply with requirements for the same grade specified in Part 2 for fabrication of type of woodwork involved.
- B. Assemble woodwork and complete fabrication at Project site to comply with requirements for fabrication in Part 2, to extent that it was not completed in the shop.
- C. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb, including tops, to a tolerance of 1/8 inch in 96 inches.
- D. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- E. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.
- F. Where practicable, use concealed fastenings for joining and assembling work. Where this is impossible, means of securing shall be placed in inconspicuous places and methods of joining and assembling submitted for Architect's approval prior to fabrication.
 - 1. Cover surface fastenings, where permitted, with matching wood plugs or wood putty.
- G. Finish exposed edges of plywood with matching solid stock. Configure internal corners to allow for contraction and expansion.
 - 1. Work which adjoins drywall, concrete, or other finish shall be fitted and scribed in careful manner and ample allowance shall be given for cutting and scribing.
- H. Paneling: Anchor paneling to supporting substrate with concealed panel-hanger clips. Do not use face fastening, unless otherwise indicated.
 - 1. Install flush paneling with no more than 1/16 inch in 96-inch vertical cup or bow and 1/8 inch in 96-inch horizontal variation from a true plane.
 - 2. 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 1/32 inch.
- I. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
 - 1. Install cabinets with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
 - 2. Maintain veneer sequence matching of cabinets with transparent finish.
 - 3. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches o.c. with No. 10 wafer-head screws sized for 1-inch penetration into wood framing, blocking, or hanging strips or No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish.
- J. Wood Bench: Coordinate with work of Section 05 50 00, "Metal Fabrications" to ensure configuration of wood fabrications and attachment to metal supports as required.

K. Field Joints: Acceptable only as shown on approved submittals. Install work with the minimum number of joints possible. Cope and miter joints; stagger joints in adjacent and related members. Field joinery shall comply with AWI quality standards specified for shop fabrication. Adjust joinery for uniform appearance.

L. Finishing:

1. Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.

3.3 ERECTION TOLERANCES

- A. Maximum variation from true position: 1/16 inch.
- B. Maximum offset from true alignment with abutting materials 1/32 inch.

3.4 ADJUSTING AND CLEANING

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

END OF SECTION

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SECTION 07 21 00
THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Extruded polystyrene board insulation.
2. Mineral board insulation.
3. Glass-fiber blanket insulation.

B. Related Requirements:

1. Section 01 45 25 "Exterior Enclosure Testing Services"
2. Section 01 83 16 "Exterior Enclosure General Requirements" for additional requirements related to the building enclosure including but not limited to:
 - a. Performance and design requirements for the exterior building enclosure.
 - b. Coordination of Work required to complete the Exterior Enclosure.
 - c. Quality Assurance and Control procedures required for the work of the Exterior Enclosure.
3. Section 07 21 19 "Foamed-In-Place Insulation".
4. Division 7 roofing and waterproofing specifications for insulation specified with those materials.
5. Division 8 curtain wall sections for insulation to be installed onto these systems.

1.2 REFERENCES

- A. Definitions:** Refer to Division 01 Section "Exterior Enclosure General Requirements" for definitions related to Exterior Enclosure.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:** Coordinate work of this section with adjacent components of the exterior enclosure. Participate in coordination required in Division 01 Section 01 83 16 "Exterior Enclosure General Requirements".

A. Preinstallation Meetings:

1. Preinstallation Conference: Conduct conference at Project site.

2. In addition to requirements specified in Division 01 Section 01 31 00 "Project Management and Coordination," include the following:

- B. Exterior Enclosure Coordination Workshops: Participate in workshops indicated in Division 01 Section 01 83 16 "Exterior Enclosure General Requirements."
- C. Sequencing / Scheduling: Comply with requirements specified in Division 1 Section 01 83 16 "Exterior Enclosure General Requirements".

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

- A. Product test reports. Submit NFPA 285 test reports indicating that full assembly, including layers specified in other sections, are compliant.
- A. Research Reports: For foam-plastic insulation, from ICC-ES.

1.6 QUALITY ASSURANCE

- A. Provide insulation required for mockup specified in Section 01 83 16.

PART 2 - PRODUCTS

2.1 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD (XPS)

- A. Extruded Polystyrene Board: ASTM C 578, maximum flame-spread and smoke-developed indexes of 25 and 450, respectively, per ASTM E 84.
 - 1. Use 25 psi minimum compressive strength in vertical below grade applications and unless otherwise indicated.
 - 2. Use 40 psi minimum compressive strength in horizontal applications except at pavers.
 - 3. Use 60 psi minimum compressive strength in horizontal applications at pavers.
- B. Use XPS below grade and along grade line behind precast cladding below the lowest line of thru-wall flashing and below slabs-on-grade.

2.2 MINERAL-WOOL BOARD

- A. Cavity Insulation: Mineral-Wool Board, Type II, Unfaced: ASTM C 612, with maximum flame-spread and smoke-developed indexes, zero, per ASTM E 84; passing ASTM E 136 for combustion characteristics. The nominal density of 4 lb/cu. ft. Water repellent for use in drained exterior wall cavities.

2.3 GLASS-FIBER BLANKET INSULATION

- A. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.

2.4 INSULATION FASTENERS

- A. At masonry veneer use insulation washers specified in Division 4 sections to secure insulation.
- A. Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.
 - 1. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - 2. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation.
- B. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized steel sheet, with a beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.
- C. Insulation-Retaining Tabs: 6" square by the 0.016-inch-thick galvanized steel sheet.

PART 3 - EXECUTION

3.1 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, water, 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.

3.2 INSTALLATION OF FOUNDATION WALL and BELOW SLAB INSULATION

- A. Coordinate with Division 07 Section for Waterproofing.
- B. Butt panels together for tight fit.
- C. Install board insulation on concrete substrates or waterproofing with adhesive.
- D. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly about insulation units.
 - 1. If not otherwise indicated, extend insulation a minimum of 24 inches in from exterior walls.

3.3 INSTALLATION OF CAVITY-WALL INSULATION

- A. Mineral Board Insulation: Fit courses of insulation between girts and wall ties and other obstructions, with edges butted tightly in both directions. Press units firmly against inside substrates. Comply with fiberglass girt manufacturer's instructions.
- A. Mechanically retain insulation between girts with small galvanized sheet metal tabs screwed to the girts where girt leg does not overlap the board. Tabs shall be installed within 6" of ends of boards and 24" on-center maximum.
- B. Mechanically retain insulation between masonry veneer ties with the insulation washers specified in Section 04 73 13 and 04 42 00.
- C. At any location where girts or washers cannot adequately retain insulation in place, provide stick pins and washers. Stickpins shall be screwed to CFMF, seal over base plate and screws with Air Barrier mastic.
- D. Seal all gaps in board insulation with slivers of insulation or spray foam recommended by insulation manufacturer.

3.4 INSTALLATION OF INSULATION FOR FRAMED CONSTRUCTION

- A. Apply insulation units to spaces between studs by method 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. 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. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically.

END OF SECTION

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SECTION 07 72 00

ROOF ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof Support Racks
2. Roof Pipe Penetration Boxes
3. Roof Hatches

B. Related Requirements:

1. Section 01 83 16 "Exterior Enclosure General Requirements" for additional requirements related to the building enclosure including but not limited to:
 - a. Performance and design requirements for the exterior building enclosure.
 - b. Coordination of Work required to complete the Exterior Enclosure.
 - c. Quality Assurance and Control procedures required for the work of the Exterior Enclosure.
2. Section 06 10 53 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
3. Section 07 41 13 "Standing Seam Metal Roofing" for roof hatches in metal roofing.
4. Section 07 53 00 "Membrane Roofing" for roofing around accessories.
5. Section 07 62 00 "Sheet Metal Flashing and Trim" for custom- and site-fabricated sheet metal flashing and trim.
6. Section 07 92 05 "Exterior Joint Sealants" for field-applied sealants between roof specialties and adjacent materials.
7. Roof top work for Divisions 21, 22, 23, 25, 26, 27 and 28.

C. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, roofing-system testing and inspecting agency representative, roofing Installer, roofing-system manufacturer's representative, Installer, structural-support Installer, and installers whose work interfaces with or affects roof specialties, including installers of roofing materials and accessories.
2. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.

3. Review special roof details, roof drainage, and condition of other construction that will affect roof specialties.

1.2 SUBMITTALS REQUIREMENTS

- A. Submit per the requirements of Section 01 33 00 Submittal Procedures and as indicated herein.
- B. CM shall coordinate submittals as indicated in 01 83 16 Paragraph 1.3-C and as otherwise indicated.
- C. Coordinate with roofing shop drawings specified in Sections 07 53 00. Include work of this section on Coordinated Roof Plan.
- D. Submit all of the following in a single complete package. Partial submittal packages shall be rejected without action.
 1. Product data
 2. Shop Drawings
 3. Delegated Design Calculations

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of roof accessory indicated.
- B. Shop Drawings: For roof accessories. Coordinate roof accessories with roofing shop drawings. Show every roof accessory on the Coordinated Roofing Plan.
- C. Shop drawings for duct, pipe and conduit support system shall be signed and sealed by an engineer licensed in the State of Maryland.

1.4 DELEGATED DESIGN SUBMITTALS

- A. Delegated-Design Submittal: For roof support racks and associated elements 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. Calculation sheets shall be cross-referenced to the exact shop drawing page number and detail for the assembly being analyzed.
 2. Anchors: Include analysis of the anchors which attach the systems to adjacent construction or structure. Analyze and identify every anchor, bolt, screw, clip, fastener or similar device for fixing the window wall in place. These cannot be indicated as "By others".
 3. Delegated Design Engineer shall sign and seal calculation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design roof support racks and support elements.
- B. General Performance: Comply with performance requirements specified, as determined by testing of systems representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
 - 1. Failure also includes the following:
 - a. Thermal stresses transferring to building structure.
 - b. Noise or vibration created by wind and thermal and structural movements.
 - c. Loosening or weakening of fasteners, attachments, and other components.
 - 2. Maximum loading from any type of base to finished roof surface: 3.0 psi.
 - 3. Maximum loading from any type of base directly to metal or concrete roof deck: As acceptable to Structural Engineer.
 - 4. Maximum loading from any type of base directly to the building structural frame: As acceptable to Structural Engineer.
 - 5. Snow Load: Comply with criteria indicated on Structural Drawings S-001
 - 6. Dead Load: Weight of equipment, ducts, pipes, and conduit to be supported plus weight of rack system.
 - 7. Wind Loads: Cladding and Component loads as indicated on S-001.
 - 8. Deflection Limits: For wind loads, no greater than 1/180 of the span.
 - 9. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.2 METAL MATERIALS

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation.
 - 1. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat.

2.3 MISCELLANEOUS MATERIALS

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

- B. Wood Nailers: Specified in Division 6, Miscellaneous Carpentry.
- C. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners.
- D. Sealants: As recommended by roof accessory manufacturer for installation indicated.

2.4 ROOF PIPE PENETRATION BOXES

- A. Prefabricated box and waterproof pipe seals for multiple pipe and conduit penetrations consisting of sheet metal curb, housing and exit seals.
 - 1. Basis of Design: AWI Series Roof VAULT by Roof Penetration Housings LLC (RPH) or approved equal.
 - 2. Box shall be air tight per ASTM E 2178
 - 3. Box shall allow for continuous R-30 roof insulation.
- B. Size: Selected to suit number and types of penetrating elements. Provide custom size unit if standard sized units are not adequate.

2.5 ROOF EQUIPMENT, PIPE, CONDUIT AND DUCT SUPPORT RACKS

- A. Support equipment, ducts and piping on roof with an engineered prefabricated system designed for installation with minimal roof penetrations, flashing or damage to the roofing material. The system shall consist of bases, hot-dipped galvanized steel frame and suitable rollers, hangers and accessories for the application. Nuts, threaded rods and washers shall be hot-dipped galvanized. Spring nuts and bolts for spring nuts will be electro-plated. Racks shall be custom designed to fit equipment, ducts, piping and conduit to be installed and the actual conditions of service.
 - 1. Basis of Design: PHP Systems Pipe Supports and Duct Supports by PHP Systems/Design,
 - 2. Miro Industries, Inc. Rooftop Support Products
 - 3. Unistrut Unipier Rooftop Supports and Cush-A-Block Bases
- B. Manufacturer shall engineer and design the support system to adequately support all conduit, pipes and conduits above roof per requirements of structural and MEP drawings and specifications and as required to not damage the indicated roofing system or exceed structural capacity of roof deck or framing.
 - 1. Coordinate with roofing system manufacturer for isolation and protection of pads.
 - 2. Wind loads shall be resisted with direct support attachment. Ballast, tie-downs and adhesive solutions are not allowed.

2.6 ROOF HATCHES

- A. Roof Hatches: Metal roof-hatch units with lids and insulated double-walled curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and weathertight perimeter gasketing, straight sides and integrally formed deck-mounting flange at perimeter bottom.
- B. Type and Size: Single-leaf lid, 30 by 36 inches.
- C. Loads: Minimum 40-lbf/sq. ft. external live load and 40-lbf/sq. ft. internal uplift load.
- D. Hatch Material: Zinc-coated (galvanized) steel sheet.
 - 1. Thickness: 0.079 inch.
 - 2. Finish: Two-coat fluoropolymer.
 - 3. Color: As selected by Architect from manufacturer's full range.
 - 4. Entire hatch shall be weather tight with fully welded corner joints on cover and curb.
- E. Construction:
 - 1. Insulation: 2-inch-thick, polyisocyanurate board.
 - a. R-Value: 12.0 according to ASTM C1363.
 - 2. Nailer: Factory-installed wood nailer continuous around hatch perimeter.
 - 3. Hatch Lid: Opaque, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
 - 4. Curb Liner: Manufacturer's standard, of same material and finish as metal curb.
 - 5. Fabricate curbs to minimum height of 12 inches above roofing surface unless otherwise indicated.
- F. Hardware: Spring operators, hold-open arm, galvanized steel spring latch with turn handles, galvanized steel butt- or pintle-type hinge system, and padlock hasps inside and outside.
- G. Safety Railing System (at roof in addition): Roof-hatch manufacturer's standard system including rails, clamps, fasteners, safety barrier at railing opening, and accessories required for a complete installation; attached to roof hatch and complying with 29 CFR 1910.23 requirements and authorities having jurisdiction.
 - 1. Height: 42 inches above finished roof deck.
 - 2. Posts and Rails: Galvanized-steel pipe, 1-1/4 inches in diameter or galvanized-steel tube, 1-5/8 inches in diameter.
 - 3. Flat Bar: Galvanized steel, 2 inches high by 3/8 inch thick.
 - 4. Maximum Opening Size: System constructed to prevent passage of a sphere 21 inches in diameter.
 - 5. Self-Latching Gate: Fabricated of same materials and rail spacing as safety railing system. Provide manufacturer's standard hinges and self-latching mechanism.

6. Post and Rail Tops and Ends: Weather resistant, closed or plugged with prefabricated end fittings.
 7. Provide weep holes or another means to drain entrapped water in hollow sections of handrail and railing members.
 8. Fabricate joints exposed to weather to be watertight.
 9. Fasteners: Manufacturer's standard, finished to match railing system.
 10. Finish: Manufacturer's standard.
 - a. Color: As selected by Architect from manufacturer's full range.
- H. Ladder Post up System (at roof at existing building): Roof-hatch manufacturer's standard device attached to the ladder to the roof, designed to telescope up after hatch is opened to provide handhold.
1. Basis of Design: Bilco LadderUp Safety Post.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Verify dimensions of roof openings for roof accessories. Install roof accessories according to manufacturer's written instructions.
1. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.
 2. Anchor roof accessories securely in place so they are capable of resisting wind loads.
 3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
 4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
- B. Pipe, Duct, Cable, and Conduit Support Systems:
1. Locate bases and support framing as indicated on approved shop drawings. Provide complete and adequate support of all piping, ducts, and conduit, whether or not all required devices are shown.
 2. The use of wood for supporting piping is not permitted.
 3. Provide supports spaced so deflection of piping does not exceed 1/240 of span.
 4. Install framing at spacing indicated, but in no case at greater than 10 feet on center.
 5. Accurately locate and align bases.
 - a. Set isolation pads in adhesive if required by manufacturer's instructions.
 - b. Place bases on isolation pads.
 - c. Adhere if required by code.

6. Set framing posts into bases and assemble framing structure as indicated.
 7. Use galvanized fasteners for galvanized framing and stainless steel fasteners for stainless steel framing.
- C. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
1. Coat concealed side of roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
- D. Seal joints with sealant as required by roof accessory manufacturer.
- E. Roof-Hatch Installation:
1. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
 2. Attach safety railing system to roof-hatch curb.
 3. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
 4. Coat concealed side of roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
 5. Seal joints with sealant as required by roof accessory manufacturer.

3.2 REPAIR AND CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A 780.
- B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 09 96 10 "Exterior High Performance Coating".
- C. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

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SECTION 07 81 00

APPLIED FIRE PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Sprayed fire-resistive materials.

1.2 DEFINITIONS

- A. SFRM: Sprayed fire-resistive materials.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
1. Review products, design ratings, restrained and unrestrained conditions, densities, thicknesses, bond strengths, and other performance requirements.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
1. Sprayed fire-resistive material.
 2. Substrate primers.
 3. Bonding agent.
 4. Metal lath.
 5. Reinforcing fabric.
 6. Reinforcing mesh.
 7. Sealer.
 8. Topcoat.
- B. Shop Drawings: Framing plans or schedules, or both, indicating the following:
1. Extent of fire protection for each construction and fire-resistance rating.
 2. Applicable fire-resistance design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction.
 3. Minimum sprayed fire-resistive material thicknesses needed to achieve required fire-resistance rating of each structural component and assembly.
 4. Treatment of sprayed fire-resistive material after application.
- C. Samples: For each exposed product and for each color and texture specified, in manufacturer standard dimensions in size.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For each type of sprayed fire-resistive material.
- C. Evaluation Reports: For sprayed fire-resistive material, from ICC-ES.
- D. Preconstruction Test Reports: For fire protection.
- E. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by sprayed fire-resistive material manufacturer as experienced and with sufficient trained staff to install manufacturer products according to specified requirements.

1.7 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Owner will engage a qualified testing agency to perform preconstruction testing on field mockups of fire protection.
 - 1. Field Mockup: Build field mockups for preconstruction testing.
 - a. Build site assembled field mockup of each type of fireproofing and substrate, in size and area required for preconstruction tests indicated.
 - 2. Provide test specimens and assemblies representative of proposed materials and construction.
- B. Preconstruction Adhesion and Compatibility Testing: Test for compliance with requirements for specified performance and test methods.
 - 1. Bond Strength: Test for cohesive and adhesive strength according to ASTM E736. Provide bond strength indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
 - 2. Density: Test for density according to ASTM E605. Provide density indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
 - 3. Verify that manufacturer, through its own laboratory testing or field experience, attests that primers or coatings are compatible with sprayed fire-resistive material.
 - 4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 - 5. For materials failing tests, obtain sprayed fire-resistive material manufacturer written instructions for corrective measures including the use of specially formulated bonding agents or primers.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not apply fire protection when ambient or substrate temperature is 44 deg F (7 deg C) or lower unless temporary protection and heat are provided to maintain

temperature at or above this level for 24 hours before, during, and for 24 hours after product application.

- B. Ventilation: Ventilate building spaces during and after application of fire protection, providing complete air exchanges according to manufacturer written instructions. Use natural means or, if they are inadequate, forced-air circulation until fire protection dries thoroughly.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Assemblies: Provide fire protection, including auxiliary materials, according to requirements of each fire-resistance design and manufacturer written instructions.
- B. Source Limitations: Obtain fire protection for each fire-resistance design from single source.
- C. Fire-Resistance Design: Indicated on Drawings, tested according to ASTM E119 or UL 263; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Steel members are to be considered unrestrained unless specifically noted otherwise.
- D. Asbestos: Provide products containing no detectable asbestos.

2.2 SPRAYED FIRE-RESISTIVE MATERIALS

- A. Sprayed Fire-Resistive Material UL415: Manufacturer standard, factory-mixed, lightweight, dry formulation, complying with indicated fire-resistance design, and mixed with water at Project site to form a slurry or mortar before conveyance and application or conveyed in a dry state and mixed with atomized water at place of application.
 - 1. Low Density Cementitious SFRM:
 - a. Carboline Co., Fireproofing Products Div.; Pyrolite 15 High Yield.
 - b. GCP Applied Technologies; Monokote Type MK-6 Series.
 - c. Isolatak International Corp.; Cafco 300 Series.
 - 2. Application: Designated for exterior use by a qualified testing agency acceptable to authorities having jurisdiction.
 - 3. Bond Strength: Minimum 150 lbf/sq. ft. (7.18 kPa) cohesive and adhesive strength based on field testing according to ASTM E736.
 - 4. Density: Not less than density specified in the approved fire-resistance design, according to ASTM E605.
 - 5. Thickness: As required for fire-resistance design indicated, measured according to requirements of fire-resistance design or ASTM E605, whichever is thicker, but not less than 0.375 inch (9 mm).
 - 6. Combustion Characteristics: ASTM E136.
 - 7. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 10 or less.

- b. Smoke-Developed Index: 10 or less.
- 8. Compressive Strength: Minimum 10 lbf/sq. in. (68.9 kPa) according to ASTM E761.
- 9. Corrosion Resistance: No evidence of corrosion according to ASTM E937.
- 10. Deflection: No cracking, spalling, or delamination according to ASTM E759.
- 11. Effect of Impact on Bonding: No cracking, spalling, or delamination according to ASTM E760.
- 12. Air Erosion: Maximum weight loss of 0.025 g/sq. ft. (0.270 g/sq. m) in 24 hours according to ASTM E859.
- 13. Fungal Resistance: Treat products with manufacturer standard antimicrobial formulation to result in no growth on specimens per ASTM G21 or rating of 10 according to ASTM D3274 when tested according to ASTM D3273.
- 14. Finish: As selected by Architect from manufacturer standard finishes.
- a. Color: As selected by Architect from manufacturer full range.

2.3 AUXILIARY MATERIALS

- A. Provide auxiliary materials that are compatible with sprayed fire-resistive material and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.
- B. Substrate Primers: Primers approved by sprayed fire-resistive material manufacturer and complying with one or both of the following requirements:
 - 1. Primer and substrate are identical to those tested in required fire-resistance design by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
 - 2. Primer bond strength in required fire-resistance design complies with specified bond strength for sprayed fire-resistive material and with requirements in UL "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction, based on a series of bond tests according to ASTM E736.
- C. Bonding Agent: Product approved by sprayed fire-resistive material manufacturer and complying with requirements in UL "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction.
- D. Metal Lath: Expanded metal lath fabricated from material of weight, configuration, and finish required, according to fire-resistance designs indicated and sprayed fire-resistive material manufacturer written instructions. Include clips, lathing accessories, corner beads, and other anchorage devices required to attach lath to substrates and to receive sprayed fire-resistive material.
- E. Reinforcing Fabric: Glass- or carbon-fiber fabric of type, weight, and form required to comply with fire-resistance designs indicated; approved and provided by sprayed fire-resistive material manufacturer.
- F. Reinforcing Mesh: Metallic mesh reinforcement of type, weight, and form required to comply with fire-resistance design indicated; approved and provided by sprayed fire-resistive material manufacturer. Include pins and attachment.
- G. Sealer: Transparent-drying, water-dispersible, tinted protective coating recommended in writing by sprayed fire-resistive material manufacturer for each fire-resistance design.

- H. Topcoat: Suitable for application over sprayed fire-resistive material; of type recommended in writing by sprayed fire-resistive material manufacturer for each fire-resistance design.
 - 1. Cement-Based Topcoat: Factory-mixed, cementitious hard-coat formulation for trowel or spray application over SFRM.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and according to each fire-resistance design.
 - 1. Verify that substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, paints, and encapsulants, or other foreign substances capable of impairing bond of fire protection with substrates under conditions of normal use or fire exposure.
 - 2. Verify that objects penetrating fire protection, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
 - 3. Verify that substrates receiving fire protection are not obstructed by ducts, piping, equipment, or other suspended construction that will interfere with fire protection application.
- B. Verify that concrete Work on steel deck is complete before beginning Work.
- C. Verify that roof construction, installation of rooftop HVAC equipment, and other related Work are complete before beginning Work.
- D. Conduct tests according to sprayed fire-resistive material manufacturer written instructions to verify that substrates are free of substances capable of interfering with bond.
- E. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Cover other Work subject to damage from fallout or overspray of fire protection materials during application.
- B. Clean substrates of substances that could impair bond of fire protection.
- C. Prime substrates where included in fire-resistance design and where recommended in writing by sprayed fire-resistive material manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive fire protection.
- D. For applications visible on completion of Project, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of fire

protection. Remove minor projections and fill voids that would telegraph through fire-resistive products after application.

3.3 APPLICATION

- A. Construct fire protection assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness, primers, sealers, topcoats, finishing, and other materials and procedures affecting fire protection Work.
- B. Comply with sprayed fire-resistive material manufacturer written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fire protection; as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.
- C. Coordinate application of fire protection with other construction to minimize need to cut or remove fire protection.
 - 1. Do not begin applying fire protection until clips, hangers, supports, sleeves, and other items penetrating fire protection are in place.
 - 2. Defer installing ducts, piping, and other items that would interfere with applying fire protection until application of fire protection is completed.
- D. Metal Decks:
 - 1. Do not apply fire protection to underside of metal deck substrates until concrete topping, if any, is completed.
 - 2. Do not apply fire protection to underside of metal roof deck until roofing is completed; prohibit roof traffic during application and drying of fire protection.
- E. Install auxiliary materials as required, as detailed, and according to fire-resistance design and sprayed fire-resistive material manufacturer written instructions for conditions of exposure and intended use. For auxiliary materials, use attachment and anchorage devices of type recommended in writing by sprayed fire-resistive material manufacturer.
- F. Spray apply fire protection to maximum extent possible. After the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by sprayed fire-resistive material manufacturer.
- G. Extend fire protection in full thickness over entire area of each substrate to be protected.
- H. Install body of fire protection in a single course unless otherwise recommended in writing by sprayed fire-resistive material manufacturer.
- I. For applications over encapsulant materials, including lockdown (post-removal) encapsulants, apply fire protection that differs in color from that of encapsulant over which it is applied.
- J. Where sealers are used, apply products that are tinted to differentiate them from fire protection over which they are applied.
- K. Provide a uniform finish complying with description indicated for each type of fire protection material and matching finish approved for required mockups.

- L. Cure fire protection according to sprayed fire-resistive material manufacturer written instructions.
- M. Do not install enclosing or concealing construction until after fire protection has been applied, inspected, and tested and corrections have been made to deficient applications.
- N. Finishes: Where indicated, apply fire protection to produce the following finishes:
 - 1. Manufacturer Standard Finishes: Finish according to manufacturer written instructions for each finish selected.
 - 2. Spray-Textured Finish: Finish left as spray applied with no further treatment.
 - 3. Rolled, Spray-Textured Finish: Even finish produced by rolling spray-applied finish with a damp paint roller to remove drippings and excessive roughness.
 - 4. Skip-Troweled Finish: Even leveled surface produced by troweling spray-applied finish to smooth out the texture and neaten edges.
 - 5. Skip-Troweled Finish with Corner Beads: Even, leveled surface produced by troweling spray-applied finish to smooth out the texture, eliminate surface markings, and square off edges.

3.4 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
 - 1. Test and inspect as required by the IBC, Subsection 17 05 .13, "Sprayed Fire-Resistant Materials."
- B. Perform the tests and inspections of completed Work in successive stages. Do not proceed with application of fire protection for the next area until test results for previously completed applications of fire protection show compliance with requirements. Tested values must equal or exceed values as specified and as indicated and required for approved fire-resistance design.
- C. Fire protection will be considered defective if it does not pass tests and inspections.
 - 1. Remove and replace fire protection that does not pass tests and inspections, and retest.
 - 2. Apply additional fire protection, per manufacturer written instructions, where test results indicate insufficient thickness, and retest.
- D. Prepare test and inspection reports.

3.5 CLEANING

- A. Cleaning: Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.

3.6 PROTECTION

- A. Protect fire protection, according to advice of manufacturer and Installer, from damage resulting from construction operations or other causes, so fire protection is without damage or deterioration at time of Substantial Completion.

3.7 REPAIRS

- A. As installation of other construction proceeds, inspect fire protection and repair damaged areas and fire protection removed due to Work of other trades.
- B. Repair fire protection damaged by other Work before concealing it with other construction.
- C. Repair fire protection by reapplying it using same method as original installation or using manufacturer recommended trowel-applied product.

END OF SECTION

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SECTION 07 84 13

PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Penetration firestopping systems for the following applications:
 - a. Penetrations in fire-resistance-rated walls.
 - b. Penetrations in horizontal assemblies.
 - c. Penetrations in smoke barriers.

1.2 PREINSTALLATION MEETINGS

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

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each penetration firestopping system, for tests performed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

- A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer written instructions.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FM Approval according to FM Approval 4991, "Approval Standard for Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

1.7 PROJECT CONDITIONS

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

1.8 COORDINATION

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics:
 - 1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
 - 2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:
 - a. Penetration firestopping systems shall bear classification marking of a qualified testing agency.
 - 1) UL in its "Fire Resistance Directory."
 - 2) Intertek Group in its "Directory of Listed Building Products."
 - 3) FM Approval in its "Approval Guide."

2.2 PENETRATION FIRESTOPPING SYSTEMS

- A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration

firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

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. 3M Fire Protection Products.
 - b. A/D Fire Protection Systems Inc.
 - c. Hilti, Inc.
 - d. Passive Fire Protection Partners.
 - e. RectorSeal.
 - f. Tremco, Inc.
- B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01 inch wg (2.49 Pa).
 1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
- C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01 inch wg (2.49 Pa).
 1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
 2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
 3. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.
- D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479, based on testing at a positive pressure differential of 0.30 inch wg (74.7 Pa).
 1. L-Rating: Not exceeding 5.0 cfm/sq. ft. (0.025 cu. m/s per sq. m) of penetration opening at and no more than 50 cfm (0.024 cu. m/s) cumulative total for any 100 sq. ft. (9.3 sq. m) at both ambient and elevated temperatures.
- E. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E84.
- F. Manufactured Piping Penetration Firestopping System: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01 inch wg (2.49 Pa).
 1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
 2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
 3. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.
 4. Sleeve: Molded-PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.

5. Stack Fitting: ASTM A48/A48M, gray-iron, hubless-pattern wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
 6. Special Coating: Corrosion resistant on interior of fittings.
- G. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.
1. Permanent forming/damming/backing materials.
 2. Substrate primers.
 3. Collars.
 4. Steel sleeves.

2.3 FILL MATERIALS

- A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer sleeve lined with an intumescent strip, a flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
- C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced intumescent elastomeric sheet bonded to galvanized-steel sheet.
- E. Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.
- F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers and lightweight aggregate formulated for mixing with water at Project site to form a 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.

2.4 MIXING

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

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings immediately to comply with manufacturer written instructions and with the following requirements:
 - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping materials.
 - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- B. Prime substrates where recommended in writing by manufacturer using that manufacturer recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 INSTALLATION

- A. General: Install penetration firestopping systems to comply with manufacturer written installation instructions and published drawings for products and applications.
- B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.
 - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.

- C. Install fill materials by proven techniques to produce the following results:
1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

- A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches (76 mm) high and with minimum 0.375- inch (9.5 mm) strokes.
1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet (4.57 m) from end of wall and at intervals not exceeding 30 feet (9.14 m).
- B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
 2. Contractor name, address, and phone number.
 3. Designation of applicable testing and inspecting agency.
 4. Date of installation.
 5. Manufacturer name.
 6. Installer name.

3.5 FIELD QUALITY CONTROL

- A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E2174.
- B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.
- C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

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

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SECTION 07 84 46

CURTAIN WALL FIRE RESISTANT JOINT SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Joints in or between fire-resistance-rated construction.
2. Joints in smoke barriers.
3. Exposed fire-resistive joint systems.

1.2 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 illustration for a particular fire-resistive joint system condition, submit illustration, with modifications marked, approved by fire-resistive joint system manufacturer fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.3 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 written recommendations.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for fire-resistive joint systems.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer, approved by the manufacturer, who has completed fire-resistive joint systems 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. 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 UL in its "Fire Resistance Directory."
- C. Preinstallation Conference: Conduct conference at Project site.

1.5 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 written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.6 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 inspecting agency at least seven days in advance of fire-resistive joint system installations; confirm dates and times on days preceding each series of installations.
- D. Do not cover up fire-resistive joint system installations that will become concealed behind other construction until inspecting agency and building inspector of authorities having jurisdiction have examined each installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Compatibility: Provide fire-resistive joint systems that are compatible with joint substrates, under conditions of service and application, as demonstrated by fire-resistive joint system manufacturer based on testing and field experience.

- B. Fire Resistance of Joint Systems: Assembly ratings and movement capabilities indicated, but with assembly ratings not less than that equaling or exceeding fire-resistance rating of constructions in which joints are located, as determined by UL 2079.
- C. Mold Resistance: Provide penetration firestopping with mold and mildew resistance rating of one or less as tested per ASTM G21.
- D. VOC Content Test Method: Comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - 1. Architectural Sealants: 250 g/L.
 - 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 - 3. Sealant Primers for Porous Substrates: 775 g/L.

2.2 FIRE-RESISTIVE JOINT SYSTEMS

- A. Joint Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.
 - 1. All fire-resistive joint systems for each kind of construction condition indicated, will be from the same manufacturer.
- B. Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined per ASTM E 1966 or UL 2079.
 - 1. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.
 - 2. Acceptable Materials: As listed in applicable UL Assembly.
 - 3. Acceptable Manufacturers: Subject to compliance with requirements, provide products as manufactured by one of the following:
 - a. Hilti, Inc.
 - b. Specified Technologies Inc.
 - c. 3M Fire Protection Products.
 - d. Tremco, Inc.; Tremco Fire Protection Systems Group.
- C. Joints in Smoke Barriers: Provide fire-resistive joint systems with ratings determined per UL 2079.
 - 1. L-Rating: Not exceeding 5.0 cfm/ft of joint at 0.30 inch wg at both ambient and elevated temperatures.
 - 2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of construction they will join.
 - 3. Acceptable Manufacturers: Subject to compliance with requirements, provide products as manufactured by one of the following:
 - a. Hilti, Inc.
 - b. Specified Technologies Inc.
 - c. 3M Fire Protection Products.
 - d. Tremco, Inc.; Tremco Fire Protection Systems Group.

- D. Exposed Fire-Resistive Joint Systems: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

2.3 ACCESSORIES

- A. 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 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 seal with substrates.

3.3 INSTALLATION

- A. General: Install fire-resistive joint systems to comply with manufacturer 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.
 - 1. 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:
 - a. The words "Warning - Fire-Resistive Joint System - Do Not Disturb. Notify Building Management of Any Damage."
 - b. Contractor name, address, and phone number.
 - c. Designation of applicable testing agency.
 - d. Date of installation.
 - e. Manufacturer name.
 - f. Installer name.

3.5 FIELD QUALITY CONTROL

- A. Inspecting Agency: Owner, at Owner option, will engage a qualified independent inspecting agency to inspect fire-resistive joint systems and to prepare inspection reports.
 - 1. Inspecting agency will state in each report whether inspected fire-resistive joint systems comply with or deviate from requirements.
- B. Remove and replace fire-resistive joint systems where inspections indicate that they do not comply with specified requirements.
- C. Additional inspections, at Contractor expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- D. Proceed with enclosing fire-resistive joint systems with other construction only after inspection reports are issued and fire-resistive joint systems comply with requirements.

- E. Manufacturer Field Services: A manufacturer direct representative (not distributor or agent) to be on-site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures.
 - 1. This will be done per manufacturer written recommendations published in their literature and drawing details.
 - 2. During installation, provide periodic visual observations to assure proper installation and application.

3.6 CLEANING AND PROTECTION

- 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.
 - 1. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

END OF SECTION

SECTION 07 92 00

JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Results:

1. Interior building joint seals.

B. Principal Products:

1. Elastomeric sealants.
2. Backing materials.

1.2 PREINSTALLATION MEETINGS

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

1.3 ACTION SUBMITTALS

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

- B. Samples for Initial Selection:** Manufacturer color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

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

- D. Joint-Sealant Schedule:** Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data:** For qualified testing agency.

- B. Product Test Reports:** For each kind of joint sealant, for tests performed by manufacturer and witnessed by a qualified testing agency or a qualified testing agency.

- C. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.
- D. Field-Adhesion-Test Reports: For each sealant application tested.
- E. Sample Warranties: For special warranties.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Product Testing: Test joint sealants using a qualified testing agency.
 - 1. Testing Agency Qualifications: Qualified according to ASTM C1021 to conduct the testing indicated.
- C. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.6 PRECONSTRUCTION TESTING

- A. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:
 - 1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
 - 2. Conduct field tests for each kind of sealant and joint substrate.
 - 3. Notify Architect seven days in advance of dates and times when test joints will be erected.
 - 4. Arrange for tests to take place with joint-sealant manufacturer technical representative present.
 - a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1.1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.
 - 1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 - 5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
 - 6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.7 FIELD CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C).
 2. When joint substrates are wet.
 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.8 WARRANTY

- A. Special Installer Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
1. Warranty Period: Five years from date of Substantial Completion.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer written specifications for sealant elongation and compression.
 2. Disintegration of joint substrates from causes exceeding design specifications.
 3. Mechanical damage caused by individuals, tools, or other outside agents.
 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

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

2.2 URETHANE JOINT SEALANTS

- A. 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 C920, Type S, Grade P, Class 25, Uses T and NT.
1. Products: Subject to compliance with requirements, provide one of the following:
- a. BASF Construction Chemicals, LLC, Building Systems; MasterSeal SL 1.
 - b. Pecora Corporation; NR-201.
 - c. Polymeric Systems, Inc.; Flexiprene 952.
- B. 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, provide one of the following:
- a. BASF Construction Chemicals, LLC, Building Systems; MasterSeal TX1.
 - b. Pecora Corporation; Dynatrol I-XL.
 - c. Tremco Incorporated; Dymonic.

2.3 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 C920, Type S, Grade NS, Class 25, Use NT.
1. Products: Subject to compliance with requirements, provide one of the following:
- a. Dow Corning Corporation; 786-M White.
 - b. GE Construction Sealants; SCS1700 Sanitary.
 - c. May National Associates, Inc., a subsidiary of Sika Corporation U.S.; Bondaflex Sil 100 WF.
 - d. Soudal USA; RTV GP.
 - e. Tremco Incorporated; Tremsil 200.

2.4 BUTYL JOINT SEALANTS

- A. Butyl-Rubber-Based Joint Sealants: ASTM C1311.
1. Products: Subject to compliance with requirements, provide one of the following:
- a. Bostik, Inc.; Chem-Calk 300.
 - b. Pecora Corporation; BC-158.

2.5 LATEX JOINT SEALANTS

- A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Construction Chemicals, LLC, Building Systems; MasterSeal NP 520.
 - b. Pecora Corporation; AC-20.
 - c. Tremco Incorporated; Tremflex 834.

2.6 JOINT-SEALANT BACKING

- A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BASF Construction Chemicals, LLC, Building Systems.
 - b. Construction Foam Products, a division of Nomaco, Inc.
- B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.7 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry.
 - c. Unglazed surfaces of ceramic tile.
 - d. Exterior insulation and finish systems.
 - 3. Remove laitance and form-release agents from concrete.
 - 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
 - a. Metal.
 - b. Glass.
 - c. Porcelain enamel.
 - d. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of sealant backings.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 - 3. Provide concave joint profile per Figure 8A in ASTM C1193 unless otherwise indicated.
 - 4. Provide flush joint profile at locations indicated on Drawings according to Figure 8B in ASTM C1193.

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 one test for each 1000 feet (300 m) of joint length thereafter or one test per each floor per elevation.
 - 2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.

- a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 3. Inspect tested joints and report on the following:
 - a. Whether sealants filled joint cavities and are free of voids.
 - b. Whether sealant dimensions and configurations comply with specified requirements.
 - c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer field-adhesion hand-pull test criteria.
 4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.
 5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
- B. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.7 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.
1. Joint Locations:
 - a. Isolation joints in cast-in-place concrete slabs.
 - b. Control and expansion joints in tile flooring.
 - c. Other joints as indicated on Drawings.

2. Joint Sealant: Urethane, S, P, 25, T, NT.
 3. Joint-Sealant Color: As selected by Architect from manufacturer full range of colors.
- B. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Locations:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Tile control and expansion joints.
 - c. Vertical joints on exposed surfaces of unit masonry, concrete, walls, and partitions.
 - d. Joints on underside of plant-precast structural concrete beams and planks.
 - e. Other joints as indicated on Drawings.
 2. Joint Sealant: Urethane, S, NS, 25, NT.
 3. Joint-Sealant Color: As selected by Architect from manufacturer full range of colors.
- C. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement.
1. Joint Locations:
 - a. Control joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints between interior wall surfaces and frames of interior doors, windows, and elevator entrances.
 - c. Other joints as indicated on Drawings.
 2. Joint Sealant: Acrylic latex.
 3. Joint-Sealant Color: As selected by Architect from manufacturer full range of colors.
- D. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Locations:
 - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - b. Tile control and expansion joints where indicated.
 - c. Other joints as indicated on Drawings.
 2. Joint Sealant: Silicone, mildew resistant, acid curing, S, NS, 25, NT.
 3. Joint-Sealant Color: As selected by Architect from manufacturer full range of colors.
- E. Joint-Sealant Application: Concealed mastics.
1. Joint Locations:
 - a. Aluminum thresholds.
 - b. Sill plates.
 - c. Other joints as indicated on Drawings.
 2. Joint Sealant: Butyl-rubber based.
 3. Joint-Sealant Color: As selected by Architect from manufacturer full range of colors.

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SECTION 07 92 05
EXTERIOR JOINT SEALANT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sealant for all exterior joints unless specified elsewhere.
2. Sealant for the interior face of exterior curtain wall and other similar elements.
3. Pre-cured Extruded Silicone Sealant
4. Primers, backers and accessories for exterior joint sealants.

B. Related Requirements:

1. Section 01 45 25 "Exterior Enclosure Field Testing"
2. Section 01 83 16 "Exterior Enclosure General Requirements" for additional requirements related to the building enclosure including but not limited to:
 - a. Performance and design requirements for the exterior building enclosure.
 - b. Coordination of Work required to complete the Exterior Enclosure.
 - c. Quality Assurance and Control procedures required for the work of the Exterior Enclosure.
3. Section 07 92 00 "Joint Sealants" for interior joints.
4. Section 08 80 10 "Exterior Glazing" for sealants required for glazing.

1.2 REFERENCES

- A. Definitions: Refer to Division 01 Section 01 83 16 "Exterior Enclosure General Requirements" for definitions related to Exterior Enclosure.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate sealant with adjacent components of the exterior enclosure. Participate in coordination required in Division 01 Section 01 83 16 "Exterior Enclosure General Requirements".
- B. Preinstallation Meetings:
1. Preinstallation Conference: Conduct conference at Project site.

2. In addition to requirements specified in Division 01 Section 01 31 00 "Project Management and Coordination," include the following:
- C. Exterior Enclosure Coordination Workshop: Participate in workshop indicated in Division 01 Section 01 83 16 "Exterior Enclosure General Requirements."
- D. Sequencing / Scheduling: Comply with requirements specified in Division 1 Section 01 83 16 "Exterior Enclosure General Requirements".

1.4 PRECONSTRUCTION TESTING

- A. Preconstruction Laboratory Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
 1. Adhesion Testing: Use ASTM C 794 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
 2. Compatibility Testing: Use ASTM C 1087 to determine sealant compatibility when in contact with glazing and gasket materials.
 3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.

1.5 SUBMITTALS REQUIREMENTS

- A. Submit per the requirements of Section 01 33 00 Submittal Procedures and as indicated herein.
- B. Submit all of the following in one package for the full scope of the work of this section, regardless of installing sub-contractor. Each sub-contractor requiring sealant shall coordinate to assemble a complete package. Partial submittal packages that do not include the full list below shall be rejected without action.
 1. Product data
 2. Samples
 3. Sealant Schedule
 4. Product Recommendation Certificates.
 5. Product test reports
 6. Pre-construction field adhesion test reports.
 7. Sample Warranties

1.6 ACTION SUBMITTALS

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

- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. Recessed Sealant Sample: Submit a 12" long sample of a bead of sealant recessed as indicated on the drawings between two lengths of aluminum tube. Sample is not for adhesion or color. Sample is to verify workmanship.
- E. 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.
 - 5. Sub-contractor installing sealant.
- F. Product Recommendation Certificates: Manufacturer shall submit certification on company letterhead signed by an authorized representative that each joint sealant selected is the best joint sealant in their product line for the conditions indicated for each kind of joint sealant and accessory.

1.7 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.
- B. Preconstruction Field-Adhesion Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.
- C. Field-Adhesion Test Reports: For each sealant application tested.
- D. Warranties: Sample of special warranties.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Company who has completed 5 sealant replacement projects of similar scope and complexity in the last 3 years and who is trained and approved for installation of sealant required for this Project.
- B. Testing Agency Qualifications: Qualified according to ASTM C 1021 to conduct the testing indicated.

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- C. Source Limitations: Obtain all joint sealant for project from single manufacturer.
- D. Manufacturer's Technical Representative Services: An authorized and approved technical representative of the joint sealant manufacturer shall visit the project site, evaluate the existing substrates and sealants and make recommendations for the best sealant within their product line for the conditions present.
 - 1. Include recommendations for sealant Class.
 - 2. Include recommendations for backing and accessories.
 - 3. Include recommendation for primer or if no primer is required.

1.9 PRECONSTRUCTION TESTING

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

1.10 PROJECT CONDITIONS

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

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.11 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: 10 years from date of Substantial Completion.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
 1. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
 2. Disintegration of joint substrates from natural causes exceeding design specifications.
 3. Mechanical damage caused by individuals, tools, or other outside agents.
 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Manufacturer and Products: Subject to compliance with requirements, provide products of the following manufacturers as recommended by manufacturer's technical representative based on indicated criteria and testing. Manufacturer's technical representative shall select the most appropriate sealant for the project specific application and substrates from manufacturer's full line.
 1. Silicone Joint Sealants:

- a. Dow
 - b. Tremco Incorporated.
 - c. Sika Corporation, Construction Products Division.
 - d. Pecora
 - e. GE Momentive
- B. VOC Emissions for Sealants: Provide certificate of compliance with California Department of Public Health (CDPH) Standard Method v1.1-2010, using the applicable exposure scenario.
- C. VOC Content for Sealants: Provide documentation of compliant VOC content per SCAQMD Rule 1168.
- D. Single Source: Select all of the types of sealant required for the project from a single manufacturer, no matter the number of sub-contractors involved.
- E. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another, with existing joint sealants and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- F. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
- G. Stain-Test-Response Characteristics: Nonstaining to porous substrates according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- H. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following:
1. Architectural sealants shall have a VOC content of 250 g/L or less.
 2. Sealants and sealant primers for nonporous substrates shall have a VOC content of 250 g/L or less.
 3. Sealants and sealant primers for nonporous substrates shall have a VOC content of 775 g/L or less.
- I. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range. Allow for 4 different colors.

2.2 SILICONE JOINT SEALANTS

- A. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, minimum Class 50, for Use NT.

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2.3 EXTRUDED-SILICONE JOINT SEALS

- A. Extruded-Silicone Joint Seals: Manufacturer's standard seal consisting of precured low-modulus silicone extrusion, with a neutral-curing silicone sealant for bonding extrusions to substrates.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; 123 Silicone Seal.
 - b. Tremco Incorporated; Spectrem Simple Seal.
 - 2. Joint Seal Width: Joint size indicated on Drawings plus 2 inch.

2.4 JOINT SEALANT BACKING

- A. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, types, as recommended in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

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

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including old joint sealant, dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include but are not limited to the following:
 - a. Concrete.
 - b. Masonry.
 - 3. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include but are not limited to the following:
 - a. Metal.
 - b. Glass.
- B. Joint Priming: Prime joint substrates where indicated by preconstruction joint-sealant-substrate tests. 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

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damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

1. Use masking tape at recessed sealant joints to protect exposed edges in recessed area.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 1. Do not leave gaps between ends of sealant backings.
 2. Do not stretch, twist, puncture, or tear sealant backings.
 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 1. Place sealants so they directly contact and fully wet joint substrates.
 2. Completely fill recesses in each joint configuration.
 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Double Line of Sealant: Provide double line of sealant where indicated.
 1. Sequencing: Install inner line and allow curing as recommended by manufacturer and minimum of 16 hours, before installing outer line of sealant.
 2. Maintain a minimum 1/2 inch cavity between inner and outer lines of sealant and backers.
 3. Where cavity between lines of sealant is interrupted, continue inner line to seal bottom of cavity and weep to exterior.
- G. 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.

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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. Joint Profile: Match existing:
4. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.
5. Provide flush joint profile where indicated per Figure 8B in ASTM C 1193.
6. Provide recessed joint configuration of recess depth and at locations indicated per Figure 8C in ASTM C 1193.
7. Use masking tape to protect surfaces adjacent to recessed tooled joints.

H. Installation of Pre-cured Extruded 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.

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 2 tests for each 1,000 feet of joint length thereafter or minimum of one test per each floor per each elevation.
2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
 - a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
3. Inspect tested joints and report on the following:

- a. Whether sealants filled joint cavities and are free of voids.
 - b. Whether sealant dimensions and configurations comply with specified requirements.
 - c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.
 4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.
 5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
- B. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.7 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces and joints on the interior surface of exterior walls.

1. Joint Locations:

- a. All joints for the exterior enclosure not in paving unless otherwise indicated.

- b. All joints for the interior side of exterior enclosure elements unless otherwise indicated.
 - 2. Joint Sealant: Silicone.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors, allow for three.
- B. Pre-cured Extruded Silicone Sealant Tape:
- 1. Joint Locations: Where indicated.
 - 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors, allow for three.

END OF SECTION

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SECTION 07 95 10
EXTERIOR EXPANSION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior wall expansion control systems.
2. Exterior wall expansion joint covers.
3. Exterior roof expansion control systems.
4. Exterior soffit expansion control systems.

B. Related Requirements:

1. Section 01 83 16 "Exterior Enclosure General Requirements" for additional requirements related to the building enclosure including but not limited to:
 - a. Performance and design requirements for the exterior building enclosure.
 - b. Coordination of Work required to complete the Exterior Enclosure.
 - c. Quality Assurance and Control procedures required for the work of the Exterior Enclosure.
 - d. Independent inspection and testing required to verify performance of the work of this section.
2. Section 07 92 05 "Exterior Joint Sealants" for liquid-applied joint sealants and for elastomeric sealants without metal frames.

1.2 REFERENCES

A. Definitions: Refer to Division 01 Section 01 83 16 "Exterior Enclosure General Requirements" for definitions related to Exterior Enclosure.

1. Definitions contained in ASTM C 119 apply to this Section.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:** Coordinate work of this section with adjacent components of the exterior enclosure. Participate in coordination required in Division 01 Section 01 83 16 "Exterior Enclosure General Requirements".
- B. Preinstallation Meetings:**

1. Preinstallation Conference: Conduct conference at Project site.
2. In addition to requirements specified in Division 01 Section 01 31 00 "Project Management and Coordination," include the following:
 - C. Exterior Enclosure Coordination Workshops: Participate in workshops indicated in Division 01 Section 01 43 25 "Exterior Enclosure Performance Requirements."
 - D. Sequencing / Scheduling: Comply with requirements specified in Division 1 Section 01 43 25 "Exterior Enclosure Performance Requirements".

1.4 SUBMITTALS REQUIREMENTS

- A. Submit per the requirements of Section 01 33 00 Submittal Procedures and as indicated herein.
- B. CM shall coordinate submittals as indicated in 018316 Paragraph 1.03-C and as otherwise indicated.
- C. Submit all of the following in a single complete package. Partial submittal packages shall be rejected without action.
 1. Product data
 2. Shop Drawings
 3. Assembly Samples
 4. Product Schedule
 5. Product Test Reports
 6. Testing Reports

1.5 ACTION SUBMITTALS

- A. Product Data. For each expansion joint cover.
- B. Shop Drawings: For complete expansion control system specified. Include plans, elevations, sections, details, splices, block-out requirement, attachments to other work, and line diagrams showing entire route of each expansion control system.
 1. Where expansion control systems change planes, provide isometric and detailed drawing depicting how components interconnect.
 2. Shop drawings shall be sufficient to allow for shop fabrication of all transitions, intersections, corners, tees, etc.
 3. Show connections to adjacent air barriers, waterproofing, roofing, vapor barriers or other moisture control layers in substrate or adjacent assemblies that contact the exterior expansion joint systems.
- C. Samples: For each exposed expansion control system and for each color and texture specified, full width by 12 inches long in size.

1. Include manufacturer's color charts showing the full range of colors and finishes available for each exposed metal and elastomeric seal material.
- D. Assembly Samples for Verification: For typical intersection of wall to roof expansion control system indicated, submit a full size assembly with each individual leg extending 24 inches from intersection. Include roof inner moisture barrier with drain tube assembly.
- E. 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.

1.6 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.

- A. Adhesion and Compatibility Testing: Provide test reports for silicone sealant per requirements of 079205.

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 and roof expansion control systems with roof expansion control systems to ensure that wall transitions are watertight.

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.

2.3 EXTERIOR EXPANSION CONTROL SYSTEMS

- A. Source Limitations: Obtain complete exterior expansion control system for all types of expansion joints indicated from single source from single manufacturer.
- B. Manufacturers: The following manufactures are approved subject to compliance with indicated requirements.
1. Emseal
 2. Watson Bowman
 3. Construction Specialties
- C. Wall-to-Wall and Soffit-to-Wall Cover:
1. Basis-of-Design Product: Emseal Colorseal. Impregnated, self-expanding, compressed foam with extruded silicone face seal.
 2. Design Criteria:
 - a. Nominal Joint Width: 4 inches.
 - b. Fire-Resistance Rating: Provide expansion control system and fire-barrier assembly with a rating not less than 2 hours.
 3. Silicone Sealant: Provide matching silicone sealant for field seals. Comply with requirements of 079205.
 4. Inner Moisture Barriers: Minimum 40 mil PVC or EPDM barrier consisting of a continuous, waterproof membrane within joint and attached to substrate on sides of joint below the primary cover.
- D. Exterior Wall Aluminum Expansion Joint Cover Plates: Extruded aluminum covers with concealed anchors, flush profile, wall-to-wall flat and corner configurations.
1. Basis of Design: Construction Specialties SMX Series or approved equivalent.
 2. Size to suit joints width.
 3. Finish: AAMA 2605 compliant high performance coating.
- E. Roof Cover:

1. Basis-of-Design Product: Emseal Roofjoint in roof to wall configuration, material to suit the roof membrane.
2. Design Criteria:
 - a. Nominal Joint Width: 4 inches.
 - b. Fire-Resistance Rating: Provide expansion control system and fire-barrier assembly with a rating not less than 2 hours.
3. Inner Moisture Barriers: Minimum 40 mil reinforced EPDM waterproof membrane within joint and attached to substrate on sides of joint below the primary cover.

2.4 FABRICATION

- A. Directional changes and terminations to be provided by factory-manufactured assemblies that preserve continuity of seal. Fabricate to extent to require only straight running joints for field work. Fabricate both inner moisture barrier and primary cover.

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.
- B. Verify adjacent roofing, waterproofing and air and weather-resistant barriers are properly installed, continuous and ready for installation of expansion covers.
- C. 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.

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. Install inner moisture barrier and stuff with semi-rigid mineral wool insulation. Coordinate installation of inner moisture barrier with installation of adjacent air barriers, waterproofing and vapor barrier membranes for continuity.

1. Verify inner moisture barrier is watertight by flood testing before covering with outer cover.
 - C. Install pre-fabricated corners, transitions, and fittings. Field fabrication is not allowed.
 - D. Make up straight butt joints between running lengths and fittings per manufacturer's instructions.
 - E. Terminate exposed ends of expansion control systems with factory-fabricated termination devices.
 - F. Provide additional compatible sealant joint between corners of wall seal and the adjacent wall.
 - G. 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.
 - H. Exterior Wall Aluminum Expansion Joint Cover Plates: Anchor to walls and install per manufactures instructions.
- 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

SECTION 08 01 52
WOOD WINDOWS RESTORATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Repairs to existing wood windows and wood door frames
 - a. Window member repair and patching.
 - b. Window member replacement.
 - c. Wood window unit removal and reinstallation.
 - d. Wood window unit removal and replacement.
 - e. Reglazing.
 - f. Window hardware repair and replacement.
 - g. New weather stripping.

B. Related Sections include the following:

1. Section 060050 "Repair of Exterior Carpentry" for repair of exterior wood not part of windows.
2. Section 090190 "Maintenance Exterior Repainting" for painting wood windows.

1.2 WINDOW SYSTEM DESCRIPTIONS

A. Window System Component Descriptions: Window component terminology shall be as identified in AWI's "Architectural Woodwork Quality Standards," Section 1000.

B. Wood window components for restoration treatment work include the following:

1. Frame Components: Head, jamb, and sill.
2. Sash Components: Stile and rails, parting bead, stop, and muntins.
3. Exterior Trim: Exterior casing, brick mould..
4. Interior Trim: Casing, stool, and apron.

C. Glazing includes glass, glazing points, glazing compounds.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Replacement Member Shop Drawings: Show fabrication and installation of replacement wood window members. Indicate materials and profiles of each replacement member, joinery, finish, and method of splicing or attaching to existing wood window.
- C. Samples for Verification: For each type of wood window replacement component required, prepared on Samples of size indicated below.
 - 1. Replacement Members: **12 inches** long for each replacement member; including frame parts, sash parts, exterior trim parts, and interior trim parts.
 - a. Where original material is indicated as the model to create new duplicate replacement members, provide Samples of duplicate replacement wood window member matching the original member.
 - 2. Repaired and Refinished Wood Window Member: Prepare Samples using existing wood window members removed from site, repaired with patching compound, and refinished.
 - 3. Hardware: Full-size units with factory-applied finish.
 - 4. Weather Stripping: **12-inch**-long sections.
- D. Qualification Data: For historic treatment specialists.
- E. Treatment Program

1.4 QUALITY ASSURANCE

- A. Window Repair Specialist Qualifications: A firm or individual experienced in historic treatment of windows similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
 - 1. Field Supervision: Require that an experienced full-time supervisor be at Project site during times that treatment of wood windows is in progress.
- B. Paint-Remover Manufacturer Qualifications: A firm regularly engaged in producing paint removers that have been used for similar historic painting applications with successful results, and with factory-trained representatives who are available for consultation and Project-site inspection and assistance at no additional cost.
- C. Treatment Program: For each phase of historic treatment process, including protection of surrounding materials on the building and Project site during operations. Describe in detail the materials, methods, equipment, and sequence of operations to be used for each phase of treatment work.

1. If materials and methods alternative to those indicated are proposed for any phase of historic treatment work, provide a written description, including evidence of successful use on other comparable projects, and a testing program to demonstrate their effectiveness for this Project.
- D. Mockups: Prepare existing windows to serve as mockups to demonstrate historic treatment methods and procedures for aesthetic effects and qualities of materials and execution. Use materials and methods proposed for completed Work and prepare mockups under same weather conditions to be expected during remainder of Work.
 1. Wood Window Repair: Prepare one entire window unit to serve as mockup to demonstrate sample repair of wood window members including frame, sash, glazing, and hardware.
 - a. Allow for Architect's review of mockup at 2 stages: 1] after window is stripped and repaired but not painted; 2] after window is painted and installed.
 2. Approved mockups shall become part of the completed Work if undisturbed at time of Substantial Completion.
- E. AWI Quality Standard: Comply with applicable requirements in AWI's "Architectural Woodwork Quality Standards" for construction, finishes, grades of wood windows, and other requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver patching and repair compounds to Project site in manufacturer's original and unopened containers, labeled with description of contents and name of manufacturer.
- B. Comply with manufacturer's written instructions for minimum and maximum temperature requirements for storage of patching materials.

1.6 SEQUENCING AND SCHEDULING

- A. Perform historic treatment of wood windows in the following sequence:
 1. Remove existing fixed and operable sash for shop repair and refinishing and reinstallation.
 2. Repair deteriorated and damaged wood members.
 3. Replace damaged and missing wood window members.
 4. Refinish existing wood windows.
 5. Repair or replace existing window hardware.
 6. Install new weather stripping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

- A. Wood: Clear fine-grained lumber; kiln dried to a moisture content of 6 to 12 percent at time of fabrication; free of blue stain, knots, pitch pockets, and surface checks.
1. Wood Species for repairs: Eastern white pine (*Pinus strobus*) heartwood only.

2.3 WOOD PATCHING MATERIALS

- A. Wood Pretreatment: Ready-to-use product designed for hardening and sealing soft fibers of wood materials that have deteriorated due to weathering and exposure and designed specifically to enhance the bond of wood patching compound to existing wood.
1. Available Products:
 - a. Abatron, Inc.; Liquidwood.
 - b. Advanced Repair Technology; Primatrate.
 - c. Wood Care Systems; Liquid TIMBR.
- B. Wood Patching Compound: 2-part epoxy-resin wood compound with a 10- to 15-minute cure at **70 deg F (21 deg C)**, in knife grade formulation and recommended by manufacturer for type of wood repair indicated. Compound shall be designed for filling damaged wood materials that have deteriorated due to weathering and exposure. Compound shall be capable of filling deep holes and capable of spreading to feather edge.
1. Available Products:
 - a. Abatron, Inc.; Liquidwood with WoodEpoxy.
 - b. Advanced Repair Technology; Primatrate with Flex-Tec HV.

- c. Gougeon Brothers, Inc.; West System.
- d. Polymeric Systems Inc.; Quickwood.
- e. Wood Care Systems; Liquid TIMBR with TIMBR Flex.

2.4 GLAZING MATERIALS

- A. Glass: 1/8 inch thick handmade blown glass in the cylinder method.
 - 1. Available Products:
 - a. AGW Old Style Window Glass
 - b. Bendheim Restoration Glass "Light"
 - c. Hollander Restoration Window Glass "Old World Colonial P-1"
- B. Glazing System:
 - 1. Glazing Points: 3/8" diamond or push style glazing points
 - 2. Glazing Compound: Manufactures standard oil or acrylic based formulation for face glazing wood windows.

2.5 REPLACEMENT WINDOW HARDWARE

- A. General: Provide complete sets of window hardware consisting of sash balances, sash locks, lifts, indicated for each window. Replacement window hardware shall be designed to smoothly operate, tightly close, and securely lock wood windows and be sized to accommodate sash weight and dimensions.
- B. Repair and Refinish Existing Hardware: Remove window hardware and repair..
- C. Replacement Hardware: Replace existing damaged or missing window hardware with new replacement hardware as follows::
- D. Sash Lock: Solid Brass sweep lock and keeper.:
 - 1. Available Products:
 - a. Architectural Resource Center Model 4217.
 - b. Phelps Company Model LKF18
 - c. Schlage Model 07MB 605.

- E. Weight and Pulley Sash-Balance Type: Concealed weight and pulley balance system including rolled steel weights, cast-brass ball bearing pulleys, bronze sash chain; provide size and capacity to hold sash stationary at any open position.

1. Available Manufacturers:

- a. Phelps Company
- b. Architectural Resource Center

- F. Window Hardware Finishes: Comply with BHMA A156.18 for base material and finish requirements indicated by the following:

1. BHMA 605: Bright brass, clear coated, brass base metal.

2.6 WEATHER STRIPPING

- A. Compression-Type Weather Stripping: Provide compressible weather stripping designed for permanently resilient sealing under bumper or wiper action and to be completely concealed when wood window is closed; polyethylene clad urethane foam elastomeric cellular preformed gaskets complying with ASTM C 50

1. Available Products:

- a. Schlegel Qlon surface-applied.

- B. Sliding Type Weather Stripping: Provide bronze spring metal in standard profiles.

1. Available Products:

- a. Accurate Series 10-UP

- C. Weather Stripping Schedule:

- 1. Perimeter excluding bottom rail: sliding type
- 2. Bottom Rail: Compression type
- 3. Meeting rail: compression type

2.7 PAINT REMOVERS

- 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. ABR Products, Inc.
- 2. Back to Nature Products Company.
- 3. Cathedral Stone Products, Inc.
- 4. Dumond Chemicals, Inc.

5. Hydroclean; Hydrochemical Techniques, Inc.
6. PROSOCO, Inc.

- B. Covered or Skin-Forming Paint Remover: Manufacturer's standard non-alkaline covered or skin-forming formulation for removing paint and coatings from wood, containing no methylene chloride.
- C. Solvent-Type Paint Remover: Manufacturer's standard water-rinsable, solvent-type gel formulation for removing paint and coatings from wood, and containing no methylene chloride.

2.8 MISCELLANEOUS MATERIALS

- A. Adhesive: Wood adhesive with a 15- to 45-minute cure at 70 deg F (21 deg C), in gunnable formulation and recommended by adhesive manufacturer for exterior wood repair.
- B. Fasteners: Provide aluminum or stainless-steel fasteners compatible with window members, trim, hardware, anchors and other components.
- C. Anchors, Clips, and Accessories: Fabricate anchors, clips, and window accessories of aluminum, nonmagnetic stainless steel, or hot-dip zinc-coated steel complying with requirements in ASTM B 633 for SC 3 (Severe) service condition.

2.9 FABRICATION OF REPLACEMENT MEMBERS

- A. General: Fabricate window replacement members and units to comply with AWI Section 1000 requirements for Custom grade.
 1. Fabricate replacement wood sash members that are reglazable without dismantling sash members.
 2. Molded Profiles of Replacement Members: Match existing profiles.
 3. Sash Members: Fabricate with mortise and tenon joints, coped, glued under pressure, and pinned. Half-lap muntin bars at intersections.
 4. Frame Members: Dado, rabbet, and plant assemble.
 5. Ease edges of replacement members as necessary to match existing members.

2.10 WOOD WINDOW FINISHES

1. Per Section 090190 "Maintenance Exterior Repainting."

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect adjacent materials from damage.
- B. Condition replacement wood members and replacement louvers to prevailing conditions at installation areas before installing.

3.2 EXAMINATION

- A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances; rough opening dimensions; levelness of sill plate; coordination with wall flashings, vapor retarders, and other built-in components; and other conditions affecting performance of work.
 - 1. Masonry Surfaces: Visibly dry and free of excess mortar, sealant, sand, and other construction debris.
 - 2. Wood Frame Walls: Dry, clean, sound, well nailed, free of voids, and without offsets at joints. Ensure that nail heads are driven flush with surfaces in opening and within **3 inches** of opening.
- B. Proceed only after unsatisfactory conditions have been corrected.

3.3 REPAIR PROCEDURES, GENERAL

- A. Window Removal: Where sashes or windows or window components are indicated for removal, cover resultant openings with temporary enclosures so that openings are weathertight during repair period.
- B. Identify removed windows, sashes, and members with numbering system to ensure reinstallation in same location. Key windows, sashes, and members to Drawings showing location of each removed unit. Mark units in a location that will be concealed after reinstallation.

3.4 REMOVAL OF SASH FOR SHOP REPAIR

- A. Remove interior window casing, parting beads, and stops as necessary to free the existing sash. Remove existing sash.
 - 1. To minimize breakage, cut/scribed paint lines at the edges of window stops and parting strips with a sharp knife before the moldings are removed.
- B. Identify removed windows, sashes and members with numbering system to ensure reinstallation in same location. Key windows, sashes, and members to Drawings

showing location of each removed unit. Mark units in a location that will be concealed after reinstallation.

- C. Install temporary plywood panels in each window/door opening so that openings are weathertight during repair period.
- D. Remove weatherstripping without damaging surrounding wood surfaces. Inspect for possible reinstallation. If salvageable, store for reinstallation.
- E. Remove all existing sealant between window and masonry opening. Clean surfaces.

3.5 PAINT REMOVAL

- A. General: Remove paint where indicated. Where cleaning methods have been attempted and further removal of the paint is required because of incompatible or unsatisfactory surfaces for repainting, remove paint to extent required by conditions.
 - 1. Brushes: Use brushes that are resistant to chemicals being used.
 - 2. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at spray tip. Adjust pressure and volume to ensure that spray methods do not damage surfaces.
 - a. Equip units with pressure gages.
 - b. Unless otherwise indicated, hold spray tip at least **6 inches (150 mm)** from surface and apply material in horizontal, back-and-forth sweeping motion, overlapping previous strokes to produce uniform coverage.
 - c. For chemical spray application, use low-pressure tank or chemical pump suitable for chemical indicated, equipped with cone-shaped spray tip.
 - d. For water-spray application, use fan-shaped spray tip that disperses water at an angle of 25 to 50 degrees.
- B. Paint Removal with Hand Tools: Remove paint manually using hand-held scrapers, sandpaper, and steel wool. Do not use other methods except as indicated as part of the treatment program and as approved by Architect.
- C. Paint Removal with Covered or Skin-Forming Paint Remover:
 - 1. Remove loose and peeling paint using water, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
 - 2. Apply paint remover to dry, painted surface with brushes or as recommended by manufacturer.
 - 3. Apply cover, if required by manufacturer, per manufacturer's written instructions.
 - 4. Allow paint remover to remain on surface for period recommended by manufacturer or as determined by preconstruction testing.
 - 5. Scrape off paint and remover and collect for disposal.

6. Rinse with water applied by low-pressure spray to remove chemicals and paint residue.
7. Use mechanical methods recommended by manufacturer to remove chemicals and paint residue.
8. Repeat process if necessary to remove all paint.

3.6 REPAIR OF WOOD WINDOWS AND FRAMES

A. Wood Dutchman Repairs

1. Cut out defective wood. Remove defective wood a minimum ¼" past the apparent area of deterioration. Whenever possible, create voids that will provide mechanical attachments, e.g. dovetails.
2. Cut Dutchman oversized for repair area and plane or sand to match profile of surround wood.
3. Dry-fit joints to ensure that joints are tight. Clean glue surfaces according to glue manufacturer's written instructions. Apply glue and clamp until glue has set.
4. Where Dutchman is adjacent to a joint fabricate to replicate existing joinery.

B. Patching with Epoxy

1. Patch wood members that have been damaged and exhibit depressions, holes, or similar voids, and that have limited rotted or decayed wood. Remove rotted or decayed wood down to sound wood.
 - a. Treat wood members with wood pretreatment prior to application of patching compound according to repair and patching material manufacturer's written instructions.
2. Apply patching compound to fill depressions, nicks, cracks, and other voids. Apply compound in layers as recommended by manufacturer until the void is completely filled. Sand patching compound smooth and flush, matching contour of existing wood member.
3. Clean spilled compound from adjacent materials immediately.

C. Muntin Replacement

1. Remove broken or deteriorated muntin.
2. Fabricate new muntin to match profile and joinery of existing.
3. Secure tenon end into window frame with glue or epoxy and stainless steel fasteners
4. provide cooped or scarf joint where new muntin joins existing and secure with glue or epoxy and stainless steel fasteners
5. Glue new putty bar into dado.

D. Glazing

1. Re-glaze all window lites and replace broken panes with new glass

- a. Remove old putty by softening the putty with a heat gun. Protect unbroken glass with sheet metal..
- b. Prep rabbets: remove old points and sand and scrape rabbet to bare wood. Prime rabbet.
- c. Bed glass in full bed of glazing compound without voids
- d. Set the glass with glazing points. Space the points evenly 4 to 6 inches apart
- e. install glazing compound and tool to approx 45 degree angle so that points are fully covered and underside of compound is not visible from interior.
- f. Allow compound to cure according to manufacturer's instructions prior to painting.

3.7 PAINTING

- A. Per Section 090190 "Maintenance Exterior Repainting."

3.8 INSTALLATION

- A. Install sashes level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction.
- B. Adjust operating sashes and hardware to provide a tight fit at contact points and with weather stripping, and to provide smooth operation and a weathertight closure. Lubricate hardware and moving parts as necessary. adjust sash weights sot that operating sash stays open at all positions.

3.9 CLEANING AND PROTECTION

- A. Protect restored window surfaces from contact with contaminating substances resulting from construction operations.
- B. Monitor restored window surfaces adjacent to and below exterior concrete and masonry surfaces during construction for presence of dirt, scum, alkaline deposits, stains, or other contaminants. If contaminating substances contact window surfaces, remove contaminants immediately according to glass manufacturer's written recommendations.
- C. Clean exposed surfaces immediately after historic treatment of wood windows. Avoid damaging coatings and finishes. Remove excess sealants, glazing and patching materials, dirt, and other substances.

- D. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

3.10 WOOD WINDOW AND FRAME REPAIR SCHEDULE

- A. Remove all sash from frames for shop repair
- B. Provide temporary protection to maintain weather tight openings
- C. Remove all glass and salvage for re-use.
- D. Remove all paint down to bare wood and repaint at all existing sash frames and trim including door frame and trim. .
- E. Repair sash and frame: for pricing assume the follow repairs
 - 1. 12 linear inches of new muntin per sash,
 - 2. 1 square foot of patching per each window (sash and frame)
 - 3. 1 square foot of dutchman per each window (sash and frame)
 - 4. Replace all parting bead per each window.
 - 5. Replace 24 linear inches of stop per each window.
- F. Reglaze all windows with salvaged glass. Provide new glass where existing lights are broken on a Unit Cost basis.
- G. Provide new or refurbish and reinstall hardware at operable sash. for pricing assume the following for each operable sash
 - 1. 1 new sash lock
 - 2. 2 new pulleys
 - 3. 2 new chains
 - 4. 2 new weights
 - 5. 2 new lifts

END OF SECTION

SECTION 08 11 10

EXTERIOR HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes custom exterior hollow-metal doors and frames.
- B. Related Requirements:
 - 1. Section 014325 "Exterior Enclosure Performance Mockup".
 - 2. Section 014525 "Exterior Enclosure Testing Services"
 - 3. Section 018316 "Exterior Enclosure General Requirements" for additional requirements related to the building enclosure including but not limited to:
 - a. Performance and design requirements for the exterior building enclosure.
 - b. Coordination of Work required to complete the Exterior Enclosure.
 - c. Quality Assurance and Control procedures required for the work of the Exterior Enclosure.
 - 4. Section 087100 "Door Hardware" for door hardware for hollow-metal doors.

1.2 REFERENCES

- A. Definitions: Refer to Division 01 Section "Exterior Enclosure General Requirements" for definitions related to Exterior Enclosure.
 - 1. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate work of this section with adjacent components of the exterior enclosure. Participate in coordination required in Division 01 Section "Exterior Enclosure General Requirements".
 - 1. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.
- B. Preinstallation Meetings:

1. Preinstallation Conference: Conduct conference at Project site.
 2. In addition to requirements specified in Division 01 Section "Project Management and Coordination," include the following:
- C. Exterior Enclosure Coordination Workshops: Participate in workshops indicated in Division 01 Section "Exterior Enclosure General Requirements."
- D. Sequencing / Scheduling: Comply with requirements specified in Division 1 Section "Exterior Enclosure General Requirements".

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Include construction details, material descriptions, core descriptions, fire-resistance ratings and finishes.
- B. Shop Drawings: Include the following:
1. Elevations of each door type including hardware.
 2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses, including hardware.
 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses, including hardware.
 4. Locations of reinforcement and preparations for hardware.
 5. Details of each different wall opening condition.
 6. Details of anchorages, joints, field splices, and connections.
 7. Details of accessories.
 8. Details of conduit and preparations for power, signal, and control systems.
- C. Samples:
1. Door: 1 ft by 1 ft corner section with hinge preparation showing edge, top and internal construction.
 2. Frame: 1 ft by 1 ft section showing assembled corner joint at head and jamb. Include hinge reinforcement and grout guard.
- D. Schedule: Provide a schedule of hollow-metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final Door Hardware Schedule.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each type of hollow-metal door and frame assembly, for tests performed by a qualified testing agency.

- B. Oversize Construction Certification: For assemblies required to be fire rated and exceeding limitations of labeled assemblies.

1.6 DELIVERY, STORAGE, AND HANDLING

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

PART 2 - PRODUCTS

2.1 REGULATORY REQUIREMENTS

- A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
 - 1. Smoke- and Draft-Control Assemblies: Provide an assembly with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.

2.2 EXTERIOR CUSTOM HOLLOW-METAL DOORS AND FRAMES

- A. Commercial Doors and Frames:
 - 1. Performance Level:
 - a. Typical: Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A.
 - 2. Doors:
 - a. Type: As indicated in the Door Schedule.
 - b. Thickness: 1-3/4 inches.
 - c. Face: Metallic-coated steel sheet, minimum thickness of 0.067 inch, with minimum G60 or A60 coating.

- d. Edge Construction: Continuously welded with no visible seam.
- e. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
- f. Bottom Edges: Close bottom edges of doors for attachment of weather stripping with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
- g. Core: Rigid foam board insulation or foamed-in-place insulation with a minimum density of 1.8 pounds per cubic foot.

1) At fire rated doors provide mineral core to meet indicated rating.

3. Frames:

- a. Materials: Metallic-coated steel sheet, minimum thickness of 0.067 inch with minimum G60 or A60 coating.
- b. Construction: Full profile continuously welded, watertight.
- c. Profile: Custom profile for thickness of wall and with extended backbend or return to allow for integration into drained cavity wall assembly.
- d. Thermally Broken: Separate interior and exterior sections with a continuous thermal break between except at stone clad door.

4. Exposed Finish: Prime.

2.3 FRAME ANCHORS

A. Jamb Anchors

- 1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
- 2. Postinstalled Expansion Type for In-Place or Existing Walls: Minimum 3/8-inch-diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location. At frame for stone clad door weld pipe spacers to plate closing throat of frame.

B. Floor Anchors: Formed from same material as frames, minimum thickness of 0.067 inch, and as follows:

- 1. Clip-type anchors sized to slip inside of closed frame profiles, with two holes to receive fasteners, adjustable for height.

2.4 MATERIALS

A. Recycled Content of Steel Products: Provide steel with minimum 30 percent total recycled content, including at least 25 percent post-consumer recycled content.

B. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.

- C. Frame Anchors: Steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.
- D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
- E. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143M.
- F. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.
- G. Glazing: Comply with requirements in Section 088010 "Exterior Glazing."
- H. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.5 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 metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
- B. Fabricate within tolerance limits in accordance with ANSI/NAAMM HMMA 841.
- C. Hollow-Metal Doors:
 - 1. Door Cores: Laminated rigid insulation or foamed-in-place insulation except at fire rated doors.
 - 2. Fire Rated Door Cores: As required to provide fire-protection ratings indicated.
 - 3. Vertical Edges for Single-Acting Doors: Continuously welded full height of door finished smooth with no visible seam. Bevel edges 1/8 inch in 2 inches.
 - 4. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets.
 - 5. Bottom Edge Closures: Close bottom edges of doors with end closures or channels of same material as face sheets.
 - 6. Exterior Doors: Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
- D. Hollow-Metal Frames: 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.

1. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 2. Provide welded shipping spreader.
 3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
 4. Floor Anchors: Provide anchor clips or countersunk holes at bottoms of jambs.
 5. Jamb Anchors: Provide number and spacing of anchors as follows:
 - a. Existing Wall Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.
 6. Head Reinforcement: For frames over 48" wide provide a steel angle or channel stiffener factory welded into head. Fabricate stiffener from steel matching frame not less than 0.093 inch thickness.
 7. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
 - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
 8. Four-sided Frames: For doors to roof and where scheduled or detailed, provide hollow metal frames with welded stainless steel checkerplate threshold. Basis of Design: Zero 669 DP-STST, size as indicated. Weld threshold to frame watertight.
- E. Fabricate concealed stiffeners and edge channels from either cold- or hot-rolled steel sheet.
- F. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule, and templates.
1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
 2. Comply with applicable requirements in ANSI/NAAMM HMMA 861 and BHMA A156.115 for preparation of hollow-metal work for hardware.

2.6 STEEL FINISHES

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

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 embedded and built-in anchors to verify actual locations before frame installation.
- C. Examine doors to waterproofed terraces or roofs to ensure that membranes have been properly installed into rough opening before placing frame.
- 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 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. Drill and tap doors and frames to receive nontemplated, 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 for doors, transoms, sidelites, borrowed lites, and other openings, of size and profile indicated. Comply with NAAMM-HMMA 840 as required by standards specified.
 - 1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
 - a. At fire-rated openings, install frames according to NFPA 80.
 - b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.

- c. Install frames with removable stops located on secure side of opening.
 - d. Install door silencers in frames before grouting.
 - e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
 - f. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
 - g. Field apply bituminous coating to backs of frames that will be filled with grout containing antifreezing agents.
- 2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
- 3. In-Place or Existing Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
- 4. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
- C. Hollow-Metal Doors: Fit hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.
 - 1. Non-Fire-Rated Steel Doors: According to HMMA standards.
 - a. Between Door and Frame Jambs and Head: 1/8 inch plus or minus 1/32 inch.
 - b. Between Edges of Pairs of Doors: 1/8 inch to 1/4 inch plus or minus 1/32 inch.
 - c. At Bottom of Door: 5/8 inch plus or minus 1/32 inch.
 - d. Between Door Face and Stop: 1/16 inch to 1/8 inch plus or minus 1/32 inch.
 - 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
- D. Install within tolerance limits in accordance with ANSI/NAAMM HMMA 841

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 Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- D. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

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SECTION 08 11 13

INTERIOR HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Interior standard steel doors and frames.
 - 2. Fire-rated composite door and sidelite frames.

1.2 COORDINATION

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

1.3 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, core descriptions, fire-resistance ratings, and finishes.
- B. Shop Drawings: Include the following:
 - 1. Elevations of each door type.
 - 2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
 - 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
 - 4. Locations of reinforcement and preparations for hardware.
 - 5. Details of each different wall opening condition.
 - 6. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
 - 7. Details of anchorages, joints, field splices, and connections.
 - 8. Details of accessories.
 - 9. Details of moldings, removable stops, and glazing.

C. Samples for Verification:

1. Finishes: For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches (75 by 127 mm).
2. Fabrication: Prepare Samples approximately 12 by 12 inches (305 by 305 mm) to demonstrate compliance with requirements for quality of materials and construction:
 - a. Doors: Show vertical-edge, top, and bottom construction; core construction; and hinge and other applied hardware reinforcement. Include separate section showing glazing if applicable.
 - b. Frames: Show profile, corner joint, floor and wall anchors, and silencers. Include separate section showing fixed hollow-metal panels and glazing if applicable.

- D. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For door inspector.

1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.
2. Egress Door Inspector: Submit documentation of compliance with NFPA 101, Section 7.2.1.15.4.

- B. Product Test Reports: For each type of fire-rated hollow-metal door and frame assembly and thermally rated door assemblies for tests performed by a qualified testing agency indicating compliance with performance requirements.

- C. Oversize Construction Certification: For assemblies required to be fire-rated and exceeding limitations of labeled assemblies.

- D. Field quality control reports.

1.6 CLOSEOUT SUBMITTALS

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

1.7 QUALITY ASSURANCE

- A. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies shall meet the qualifications set forth in NFPA 80, section 5.2.3.1 and the following:
1. Door and Hardware Institute Fire and Egress Door Assembly Inspector, FDAI, certification.

- B. Egress Door Inspector Qualifications: Inspector for field quality control inspections of egress door assemblies shall meet the qualifications set forth in NFPA 101, Section 7.2.1.15.4 and the following:

1. Door and Hardware Institute Fire and Egress Door Assembly Inspector, FDAI, certification.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
1. Provide additional protection to prevent damage to factory-finished units.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow-metal doors and frames vertically under cover at Project site with head up. Place on minimum 4 inch (102 mm) high wood blocking. Provide minimum 1/4 inch (6 mm) space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Curries Company; an Assa Abloy Group company.
 2. Pioneer Industries, Inc.
 3. Republic Doors and Frames, an Allegion Company.
 4. Steelcraft; an Allegion company.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated on Drawings, based on testing at positive pressure according to NFPA 252 or UL 10C.
1. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.
 2. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
- B. Fire-Rated, Borrowed-Lite Assemblies: Assemblies complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9.

- C. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.38 deg Btu/F x h x sq. ft. (2.16 W/K x sq. m), minimum when tested according to ASTM C518.

2.3 INTERIOR STANDARD STEEL DOORS AND FRAMES

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

- B. Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 2; ANSI/SDI A250.4, Level B.

1. Doors:

- a. Type: As indicated in the Door and Frame Schedule.
- b. Thickness: 1-3/4 inches (44.5 mm).
- c. Face: Metallic-coated steel sheet, minimum thickness of 0.042 inch (1.0 mm).
- d. Edge Construction: Model 1, Full Flush.
- e. Core: Manufacturer standard.
- f. Fire-Rated Core: Manufacturer standard core for fire-rated doors.

2. Frames:

- a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm).
- b. Sidelite Frames: Fabricated from same thickness material as adjacent door frame.
- c. Construction: Full profile welded.

3. Exposed Finish: Architect selected.

2.4 FIRE-RATED COMPOSITE DOOR AND SIDELITE FRAMES

- A. Fire rated composite core frames with with applied wood veneer.

1. Basis of Design Product:

- a. Grandoor Fire-rated Frames.
- b. Or approved equal.

2. Fire Rating: See Drawings.

3. Veneer: Architect selected.

4. Gasketing: Surface-applied.

2.5 BORROWED LITES

- A. Fabricate of metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm).

- B. Construction: Full profile welded.

- C. Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections due to shipping or handling limitations, provide

alignment plates or angles at each joint, fabricated of metal of same or greater thickness as metal as frames.

- D. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

2.6 FRAME ANCHORS

A. Jamb Anchors:

1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches (610 mm) of frame height above 7 feet (2.1 m).
3. Postinstalled Expansion Anchor: Minimum 3/8 inch (9.5 mm) diameter bolts with expansion shields or inserts, with manufacturer standard pipe spacer.

B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.

C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2 inch (51 mm) height adjustment. Terminate bottom of frames at top of underlayment.

D. Material: ASTM A879/A879M, Commercial Steel - CS, 04Z (12G) coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized according to ASTM A153/A153M, Class B.

2.7 MATERIALS

A. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel - CS, Type B.

B. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A153/A153M.

C. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

D. Mineral-Fiber Insulation: ASTM C665, Type I, blankets without membrane facing; consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.

E. Glazing: Comply with requirements in Section 08 80 00 "Glazing."

2.8 FABRICATION

A. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch (19 mm)

beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.

- B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
 - 1. Sidelite Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding, or by rigid mechanical anchors.
 - 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - 3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
 - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
- C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to ANSI/SDI A250.6, the Door Hardware Schedule, and templates.
 - 1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
 - 2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.
- D. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with mitered hairline joints.
 - 1. Provide stops and moldings flush with face of door, and with beveled stops unless otherwise indicated.
 - 2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
 - 3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.
 - 4. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
 - 5. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c. and not more than 2 inches (51 mm) o.c. from each corner.

2.9 STEEL FINISHES

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

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

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

- A. Install doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer written instructions.
- B. Frames: Comply with ANSI/SDI A250.11.
 - 1. Install frames in accordance with manufacturer instructions.
 - 2. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
 - a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
 - b. Install frames with removable stops located on secure side of opening.
 - 3. Fire-Rated Openings: Install frames according to NFPA 80.
 - 4. Floor Anchors: Secure with postinstalled expansion anchors.
 - a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
 - 5. Solidly pack mineral-fiber insulation inside frames.
 - 6. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
 - 7. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
 - 8. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.

- c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.
- C. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.
 - 1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8.
 - 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
 - 3. Smoke-Control Doors: Install doors according to NFPA 105.
- D. Glazing: Comply with installation requirements in Section 08 80 00 "Glazing" and with hollow-metal manufacturer written instructions.

3.3 REPAIR

- A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer written instructions.

END OF SECTION

SECTION 08 14 16

FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Five-ply flush wood veneer-faced doors for transparent finish.
2. Factory finishing flush wood doors.
3. Factory fitting flush wood doors to frames and factory machining for hardware.

1.2 PREINSTALLATION MEETINGS

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

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:

1. Door core materials and construction.
2. Door edge construction.
3. Door face type and characteristics.
4. Door trim for openings.
5. Door frame construction.
6. Factory-machining criteria.
7. Factory- finishing specifications.

- B. Shop Drawings:** Indicate location, size, and hand of each door; elevation of each type of door; construction details not covered in Product Data; and the following:

1. Door schedule indicating door location, type, size, fire protection rating, and swing.
2. Door elevations, dimension and locations of hardware, lite and louver cutouts, and glazing thicknesses.
3. Details of frame for each frame type, including dimensions and profile.
4. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
5. Dimensions and locations of blocking for hardware attachment.
6. Dimensions and locations of mortises and holes for hardware.
7. Clearances and undercuts.
8. Requirements for veneer matching.
9. Doors to be factory finished and application requirements.

- C. Samples for Initial Selection:** For factory-finished doors.

D. Samples for Verification:

1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches (200 by 250 mm), for each material and finish. For each wood species and transparent finish, provide set of three Samples showing typical range of color and grain to be expected in finished Work.
2. Polymer edging, in manufacturer standard colors.
3. Corner sections of doors, approximately 8 by 10 inches (200 by 250 mm), with door faces and edges representing actual materials to be used.
4. Louver blade and frame sections, 6 inches (150 mm) long, for each material and finish specified.
5. Frames for light openings, 6 inches (150 mm) long, for each material, type, and finish required.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For door inspector.

1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.
2. Egress Door Inspector: Submit documentation of compliance with NFPA 101, Section 7.2.1.15.4.
3. Submit copy of DHI's Fire and Egress Door Assembly Inspector, FDAI, certificate.

B. Field quality-control reports.

C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Special warranties.

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

1.6 QUALITY ASSURANCE

A. Manufacturer Certification: Licensed participant in AWI Quality Certification Program.

B. Fire-Rated Door Inspector Qualifications: Inspector for field quality-control inspections of fire-rated door assemblies shall comply with qualifications set forth in NFPA 80, Section 5.2.3.1 and the following:

1. DHI's Fire and Egress Door Assembly Inspector, FDAI, certification.

C. Egress Door Inspector Qualifications: Inspector for field quality-control inspections of egress door assemblies shall comply with qualifications set forth in NFPA 101, Section 7.2.1.15.4 and the following:

1. DHI's Fire and Egress Door Assembly Inspector, FDAI, certification.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer written instructions.
- B. Package doors individually in cardboard cartons, and wrap bundles of doors in plastic sheeting.
- C. Mark each door on bottom rail with opening number used on Shop Drawings.

1.8 FIELD CONDITIONS

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

1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Delamination of veneer.
 - b. Warping (bow, cup, or twist) more than 1/4 inch (6.4 mm) in a 42-by-84-inch (1067-by-2134-mm) section.
 - c. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch (0.25 mm in a 76.2-mm) span.
 - 2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
 - 3. Warranty Period for Solid-Core Exterior Doors: Five years from date of Substantial Completion.
 - 4. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain flush wood doors indicated to be blueprint matched with paneling from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Wood Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-

protection ratings and temperature-rise limits indicated on Drawings, based on testing at positive pressure in accordance with UL 10C or NFPA 252.

1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

2.3 FLUSH WOOD DOORS, GENERAL

- A. Quality Standard: In addition to requirements specified, comply with AWI/AWMAC/WI "Architectural Woodwork Standards."

1. The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with the Contract Documents in addition to those of the referenced quality standard.

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

- A. Interior Doors:

1. Performance Grade: ANSI/WDMA I.S. 1A Heavy Duty, unless otherwise indicated.
2. Performance Grade:
3. ANSI/WDMA I.S. 1A Grade: Premium.
4. Faces: Single-ply wood veneer not less than 1/50 inch (0.508 mm) thick.
 - a. Species: As selected by Architect.
 - b. Cut: As selected by Architect.
 - c. Match between Veneer Leaves: Slip match.
 - d. Assembly of Veneer Leaves on Door Faces: Balance match.
 - e. 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 10 feet (3 m) or more.
5. Exposed Vertical and Top Edges: Same species as faces or a compatible species - Architectural Woodwork Standards edge Type A.
 - a. Fire-Rated Single Doors: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed vertical edges.
 - b. Fire-Rated Pairs of Doors: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
 - c. Fire-Rated Pairs of Doors: Provide formed-steel edges and astragals with intumescent seals.
 - 1) Finish steel edges and astragals with baked enamel.
 - 2) Finish steel edges and astragals to match door hardware, locksets or exit devices.

- d. Mineral-Core Doors: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
 - 1) Screw-Holding Capability: 475 lbf (2110 N) in accordance with WDMA T.M. 10.
- 6. Core for Non-Fire-Rated Doors:
 - a. WDMA I.S. 10 structural composite lumber.
 - 1) Screw Withdrawal, Door Face: 475 lbf (2110 N).
 - 2) Screw Withdrawal, Vertical Door Edge: 475 lbf (2110 N).
- 7. Core for Fire-Rated Doors: As required to achieve fire-protection rating indicated on Drawings.
 - a. Blocking for Mineral-Core Doors: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated on Drawings as needed to eliminate through-bolting hardware.
- 8. Construction: Five plies, hot-pressed bonded, vertical and horizontal edging is bonded to core, with entire unit abrasive planed before veneering.

2.5 LIGHT FRAMES AND LOUVERS

- A. Metal Frames for Light Openings in Fire-Rated Doors: Manufacturer standard frame formed of 0.048-inch- (1.2-mm-) thick, cold-rolled steel sheet; with baked-enamel- or powder-coated finish; and approved for use in doors of fire-protection rating indicated on Drawings.

2.6 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated.
 - 1. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
 - 2. Comply with NFPA 80 requirements for fire-rated doors.
- B. Factory machine doors for hardware that is not surface applied.
 - 1. Locate hardware to comply with DHI-WDHS-3.
 - 2. Comply with final hardware schedules, door frame Shop Drawings, ANSI/BHMA-156.115-W, and hardware templates.
 - 3. Coordinate with hardware mortises in metal frames, to verify dimensions and alignment before factory machining.
 - 4. For doors scheduled to receive electrified locksets, provide factory-installed raceway and wiring to accommodate specified hardware.
 - 5. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.

C. Transom and Side Panels:

1. Fabricate matching panels with same construction, exposed surfaces, and finish as specified for associated doors.
2. Finish bottom edges of transoms and top edges of rabbeted doors same as door stiles.
3. Fabricate door and transom panels with full-width, solid-lumber meeting rails.
4. Provide factory-installed spring bolts for concealed attachment into jambs of metal door frames.

D. 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 08 80 00 "Glazing."

2.7 FACTORY FINISHING

A. Comply with referenced quality standard for factory finishing.

1. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
2. Finish faces, all four edges, edges of cutouts, and mortises.
3. Stains and fillers may be omitted on bottom edges, edges of cutouts, and mortises.

B. Factory finish doors.

C. Transparent Finish:

1. ANSI/WDMA I.S. 1A Grade: Premium.
2. Finish: ANSI/WDMA I.S. 1A TR-6 Catalyzed Polyurethane.
3. Staining: As selected by Architect from manufacturer full range.
4. Sheen: Satin.

PART 3 - EXECUTION

3.1 EXAMINATION

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

1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
2. Reject doors with defects.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Hardware: For installation, see Section 08 71 00 "Door Hardware."

- B. Install doors to comply with manufacturer written instructions and referenced quality standard, and as indicated.
- C. Install frames level, plumb, true, and straight.
 - 1. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches (3.2 mm in 2400 mm).
 - 2. Anchor frames to anchors or blocking built in or directly attached to substrates.
 - a. Secure with countersunk, concealed fasteners and blind nailing.
 - b. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork.
 - 1) For factory-finished items, use filler matching finish of items being installed.
 - 3. Install fire-rated doors and frames in accordance with NFPA 80.
 - 4. Install smoke- and draft-control doors in accordance with NFPA 105.
- D. Job-Fitted Doors:
 - 1. Align and fit doors in frames with uniform clearances and bevels as indicated below.
 - a. Do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors.
 - 2. Machine doors for hardware.
 - 3. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
 - 4. Clearances:
 - a. Provide 1/8 inch (3.2 mm) at heads, jambs, and between pairs of doors.
 - b. Provide 1/8 inch (3.2 mm) from bottom of door to top of decorative floor finish or covering unless otherwise indicated on Drawings.
 - c. Where threshold is shown or scheduled, provide 1/4 inch (6.4 mm) from bottom of door to top of threshold unless otherwise indicated.
 - d. Comply with NFPA 80 for fire-rated doors.
 - 5. Bevel non-fire-rated doors 1/8 inch in 2 inches, 3-1/2 degrees, at lock and hinge edges.
 - 6. Bevel fire-rated doors 1/8 inch in 2 inches, 3-1/2 degrees, at lock edge; trim stiles and rails only to extent permitted by labeling agency.
- E. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
- F. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 FIELD QUALITY CONTROL

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

B. Inspections:

1. Provide inspection of installed Work through AWI Quality Certification Program, certifying that wood doors and frames, including installation, comply with requirements of AWI/AWMCA/WI "Architectural Woodwork Standards" for the specified grade.
2. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, Section 5.2.
3. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements in accordance with NFPA 101, Section 7.2.1.15.

C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in NFPA 80 and NFPA 101.

3.4 ADJUSTING

A. Operation: Rehang or replace doors that do not swing or operate freely.

B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION

SECTION 08 31 13

ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Access doors and frames.
2. Fire-rated access doors and frames.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, fire ratings, material descriptions, dimensions of individual components and profiles, and finishes.

B. Samples: For each type of access door and frame and for each finish specified, complete assembly minimum 6 by 6 inches (150 by 150 mm) in size.

C. Product Schedule: For access doors and frames. Use same designations indicated on Drawings.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing and inspecting agency.

1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.
2. Submit copy of DHI Fire and Egress Door Assembly Inspector, FDAI, certificate.

1.4 CLOSEOUT SUBMITTALS

A. Record Documents: For fire-rated doors, list of applicable room name and number in which access door is located.

1.5 QUALITY ASSURANCE

A. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies shall meet the qualifications set forth in NFPA 80, Section 5.2.3.1 and the following:

1. Door and Hardware Institute Fire and Egress Door Assembly Inspector, FDAI, certification.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Access Doors and Frames: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, according to NFPA 252 or UL 10B.

2.2 ACCESS DOORS AND FRAMES

- A. Flush Access Doors with Exposed Flanges:

1. Description: Face of door flush with frame, with exposed flange and concealed hinge.
2. Locations: Wall and ceiling.
3. Door Size: See Drawings.
4. Metallic-Coated Steel Sheet for Door: Nominal 0.064 inch (1.63 mm), 16 gage, factory primed.
5. Frame Material: Same material, thickness, and finish as door.
6. Latch and Lock: Cam latch, screwdriver operated.

- B. Flush Access Doors with Concealed Flanges:

1. Description: Face of door flush with frame; with concealed flange for gypsum board installation and concealed hinge.
2. Locations: Wall and ceiling.
3. Door Size: See Drawings.
4. Metallic-Coated Steel Sheet for Door: Nominal 0.064 inch (1.63 mm), 16 gage factory primed.
5. Latch and Lock: Cam latch, key operated.

2.3 FIRE-RATED ACCESS DOORS AND FRAMES

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

1. Description: Door face flush with frame, with exposed flange, self-closing door, and concealed hinge.
2. Optional Features: Self latching with automatic closer and interior latch release.
3. Locations: Wall.
4. Door Size: See Drawings.
5. Fire-Resistance Rating: Not less than that of adjacent construction.
6. Metallic-Coated Steel Sheet for Door: Nominal 0.040 inch (1.02 mm), 20 gage, factory primed.
7. Frame Material: Same material, thickness, and finish as door.
8. Latch and Lock: Self-latching door hardware, operated by key.

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. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel, CS, Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.
- D. Frame Anchors: Same material as door face.
- E. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329.

2.5 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.
 - 1. For concealed flanges with drywall bead, provide edge trim for gypsum panels securely attached to perimeter of frames.
- D. Latch and Lock Hardware:
 - 1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.
 - 2. Keys: Furnish two keys per lock and key all locks alike.
 - 3. Mortise Cylinder Preparation: Prepare door panel to accept cylinder specified in Section 08 71 00 "Door Hardware."

2.6 FINISHES

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

- D. Painted Finishes: Comply with coating manufacturer written instructions for cleaning, conversion coating, and applying and baking finish.
 - 1. Factory Primed: Apply manufacturer standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.
 - 2. Factory Finished: Apply manufacturer standard baked-enamel or powder-coat finish immediately after cleaning and pretreating, with minimum dry-film thickness of 1 mil (0.025 mm) for topcoat.
 - a. Color: As selected by Architect from full range of industry colors.

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 written instructions for installing access doors and frames.

3.3 FIELD QUALITY CONTROL

- A. Inspection Agency: Engage a qualified inspector to perform inspections and to furnish reports to Architect.
- B. Inspections:
 - 1. Fire-Rated Door Inspections: Inspect each fire-rated access door in accordance with NFPA 80, Section 5.2.
- C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.
- E. Prepare and submit separate inspection report for each fire-rated access door indicating compliance with each item listed in NFPA 80.

3.4 ADJUSTING

- A. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION

SECTION 08 36 13

SECTIONAL DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sectional-door assemblies.

1.2 ACTION SUBMITTALS

A. Product Data: For each type and size of sectional door and accessory.

1. Include construction details, material descriptions, dimensions of individual components, profile door sections, and finishes.
2. For power-operated doors, include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.

B. Shop Drawings: For each installation and for components not dimensioned or detailed in manufacturer product data.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
4. Include diagrams for power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified, in manufacturer standard size.

D. Samples for Verification: For each type of exposed finish and for each color and texture required on the following components, in manufacturer standard sizes:

1. Metal for door sections.
2. Hardware.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Sample Warranties: For manufacturer warranty and finish warranty.

NOT FOR BID

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For sectional doors to include in maintenance manuals.
- B. Manufacturer warranty.
- C. Finish warranty.

1.5 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.
- B. Regulatory Requirements: Comply with provisions in the U.S. Department of Justice "2010 ADA Standards for Accessible Design" and ICC A117.1 applicable to sectional doors.

1.6 WARRANTY

- A. Manufacturer Warranty: Manufacturer agrees to repair or replace components of sectional doors 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. Failure of components or operators before reaching required number of operation cycles.
 - c. Faulty operation of hardware.
 - d. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use; rust through.
 - e. Delamination of exterior or interior facing materials.
 - 2. Warranty Period: Three years from date of Substantial Completion.
- B. Finish Warranty: Manufacturer agrees to repair or replace components that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Warranty Period: Ten years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS, GENERAL

- A. Source Limitations: Obtain sectional doors from single source from single manufacturer.
 - 1. Obtain operators and controls from sectional door manufacturer.

NOT FOR BID

2.2 PERFORMANCE REQUIREMENTS

- A. General Performance: Provide sectional doors that comply with performance requirements specified without failure from defective manufacture, fabrication, installation, or other defects in construction and without requiring temporary installation of reinforcing components.
- B. Structural Performance, Exterior Doors: Capable of withstanding the design wind loads.
 - 1. Design Wind Load: See Drawings.
 - 2. Testing: In accordance with ASTM E330/E330M or DASMA 108 for garage doors and complying with DASMA 108 acceptance criteria.
 - 3. Deflection Limits: Design sectional doors to withstand design wind loads without evidencing permanent deformation or disengagement of door components.
 - a. Deflection of door sections in horizontal open position shall not exceed 1/120 of door width.
 - b. Deflection of horizontal track assembly shall not exceed 1/240 of door height.

2.3 SECTIONAL-DOOR ASSEMBLY

- A. Steel Sectional Door: Provide sectional door formed with hinged sections and fabricated so that finished door assembly is rigid and aligned with tight hairline joints; free of warp, twist, and deformation; and complies with requirements in DASMA 102.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Overhead Door Corporation Heavy Duty Springless Service Doors 610S, or comparable product by one of the following:
 - a. C.H.I. Overhead Doors.
 - b. Raynor.
 - c. Wayne-Dalton Corp.
- B. Operation Cycles: Door components and operators capable of operating for not less than 20,000 operation cycles. One operation cycle is complete when door is opened from closed position to the open position and returned to closed position.
- C. Air Infiltration: Maximum rate of 0.08 cfm/sq. ft. when tested in accordance with ASTM E283 or DASMA 105.
- D. U-Value: 0.1 Btu/sq. ft. x h x deg F.
- E. Steel Door Sections: ASTM A653/A653M, zinc-coated galvanized, cold-rolled, commercial steel sheet with G90 (Z275) zinc coating.
 - 1. Door-Section Thickness: 2 inches (51 mm).
 - 2. Section Faces: For Door E005.
 - a. Thermal-Break Construction: Provide sections with continuous thermal-break construction separating the exterior and interior faces of door.
 - b. Exterior Face: Fabricated from single sheets, not more than 24 inches (610 mm) high; with horizontal meeting edges rolled to continuous, interlocking, keyed, rabbeted, shiplap, or tongue-in-groove, weather- and pinch-resistant seals and reinforcing flange return.

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- 1) Steel Sheet Thickness: 0.015 inch (0.38 mm) nominal coated thickness.
 - 2) Surface: Manufacturer standard, flat.
 - c. Interior Face: Enclose insulation completely within steel exterior facing and interior facing material, with no exposed insulation. Provide the following interior-facing material:
 - 1) Zinc-Coated, Galvanized Steel Sheet: With minimum nominal coated thickness of 0.015 inch (0.38 mm).
3. Section Faces: For Door E011.
 - a. Fabricated from single sheets, not more than 24 inches (610 mm) high; with horizontal meeting edges rolled to continuous, interlocking, keyed, rabbeted, shiplap, or tongue-in-groove, weather- and pinch-resistant seals and reinforcing flange return.
 - 1) Steel Sheet Thickness: 0.015 inch (0.38 mm) nominal coated thickness.
 - 2) Surface: Manufacturer standard, flat and perforated with Style 653 slat holes, 22 percent open.
 - a) Perforated Area: Middle 10 feet of door.
4. End Stiles: 16 gage with thermal break.
5. Thermal Insulation: Insulate interior of steel sections with door manufacturer standard CFC-free insulation of type indicated below:
 - a. Board Insulation: polyurethane, secured to exterior face sheet.
 - b. Foamed-in-Place Insulation: Polyurethane, foamed in place to completely fill interior of section and pressure bonded to face sheets to prevent delamination under wind load.
 - c. Fire-Resistance Characteristics: Maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, in accordance with ASTM E84.
- F. Track: Manufacturer standard, galvanized-steel, standard-lift track system. Provide complete system including brackets, bracing, and reinforcement to ensure rigid support of ball-bearing roller guides.
 1. Material: Galvanized steel, ASTM A653/A653M, minimum G60 (Z180) zinc coating.
 2. Size: As recommended in writing by manufacturer for door size, weight, track configuration and door clearances indicated on Drawings.
 3. Track Reinforcement and Supports: Provide galvanized-steel members to support track without sag, sway, and vibration during opening and closing of doors. Slot vertical sections of track spaced 2 inches (51 mm) apart for door-drop safety device.
- G. Weatherseals: Replaceable, adjustable, continuous, compressible weather-stripping gaskets of flexible vinyl, rubber, or neoprene fitted to bottom of door.

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- H. Hardware: Heavy-duty, corrosion-resistant hardware, with hot-dip galvanized, stainless steel, or other corrosion-resistant fasteners, to suit door type.
1. Hinges: Heavy-duty, galvanized-steel hinges of not less than 0.079 inch (2.01 mm) nominal coated thickness at each end stile and at each intermediate stile, in accordance with manufacturer written recommendations for door size.
 - a. Attach hinges to door sections through stiles and rails with bolts and lock nuts or lock washers and nuts. Use rivets or self-tapping fasteners where access to nuts is impossible.
 - b. Provide double-end hinges where required for doors more than 16 ft. (4.88 m) wide unless otherwise recommended by door manufacturer in writing.
 2. Rollers: Heavy-duty rollers with steel ball bearings in case-hardened steel races, mounted to suit slope of track. Extend roller shaft through both hinges where double hinges are required. Match roller-tire diameter to track width.
 - a. Roller-Tire Material: Manufacturer standard.
- I. Locking Device:
1. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on single-jamb side, operable from inside only.
 2. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded deadbolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.
 - a. Lock Cylinders: Cylinders complying with Section 08 71 00 "Door Hardware" requirements.
 - b. Keying: Keyed to building keying system.
 - c. Keys: For each cylinder.
 3. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.
- J. Counterbalance Mechanism:
1. Torsion Spring: Adjustable-tension torsion springs complying with requirements of DASMA 102 for number of operation cycles indicated, mounted on torsion shaft.
 2. Cable Drums and Shaft for Doors: Cast-aluminum cable drums mounted on torsion shaft and grooved to receive door-lifting cables as door is raised.
 - a. Mount counterbalance mechanism with manufacturer standard ball-bearing brackets at each end of torsion shaft.
 - b. Provide one additional midpoint bracket for shafts up to 16 ft. (4.88 m) long and two additional brackets at one-third points to support shafts more than 16 ft. (4.88 m) long unless closer spacing is recommended in writing by door manufacturer.
 3. Cables: Galvanized-steel, multistrand, lifting cables with cable safety factor of at least 5 to 1.
 4. Cable Safety Device: Include a spring-loaded steel or bronze cam mounted to bottom door roller assembly on each side and designed to automatically stop door if lifting cable breaks.

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5. Bracket: Provide anchor support bracket as required to connect stationary end of spring to the wall and to level the shaft and prevent sag.
 6. Bumper: Provide spring bumper at each horizontal track to cushion door at end of opening operation.
- K. Electric Door Operator: Electric door operator assembly of size and capacity recommended by door manufacturer for door and operation cycles specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral gearing for locking door, and accessories required for proper operation.
1. Comply with NFPA 70.
 2. Control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6; with NFPA 70, Class 2 control circuit, maximum 24 V ac or dc.
 3. Safety: Listed in accordance with UL 325 by a qualified testing agency for commercial or industrial use; moving parts of operator enclosed or guarded if exposed and mounted at 8 ft. (2.4 m) or lower.
 4. Usage Classification: Heavy duty, 25 or more cycles per hour and more than 90 cycles per day.
 5. Operator Type: Manufacturer standard for door requirements.
 6. Motor: Reversible-type with controller, disconnect switch for interior, clean, and dry motor exposure. Use adjustable motor-mounting bases for belt-driven operators.
 - a. Motor Size: As required to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. (203 mm/s) and not more than 12 in./sec. (305 mm/s), without exceeding nameplate ratings or service factor.
 7. Limit Switches: Equip motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.
 8. Obstruction Detection: Automatic external entrapment protection consisting of automatic safety sensor capable of protecting full width of door opening. Activation of device immediately stops and reverses downward door travel.
 - a. Monitored Entrapment Protection: Electric sensor edge on bottom section designed to interface with door-operator control circuit to detect damage to or disconnection of sensor and complying with requirements in UL 325.
 9. Control Station: Flush or Surface mounted, three-position (open, close, and stop) control.
 - a. Operation: Push button interior and key exterior.
 - b. Interior-Mounted Unit: Full-guarded, surface-mounted, standard-duty, weatherproof-type, NEMA ICS 6, Type 4 enclosure.
 - c. Exterior-Mounted Unit: Full-guarded, surface-mounted, standard-duty, weatherproof type, NEMA ICS 6, Type 4 enclosure.
 10. Emergency Manual Operation: Chain type designed so required force for door operation does not exceed 35 lbf (155 N).
 11. Emergency Operation Disconnect Device: Hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
 12. Motor Removal: Design operator so motor can be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.

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- L. Metal Finish: Comply with NAAMM/NOMMA "Metal Finishes Manual for Architectural and Metal Products (AMP 500-06)" for recommendations for applying and designating finishes.
 - 1. Baked-Enamel or Powder-Coat Finish: Manufacturer standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer written instructions for cleaning, pretreatment, application, and minimum dry film thickness.
 - a. Finish: Comply with AAMA 2604 requirements for pigmented organic coatings applied to aluminum extrusions and panels.
 - b. Color and Gloss: As selected by Architect from manufacturer full range.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install sectional doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; in accordance with manufacturer written instructions.
- B. Tracks:
 - 1. Fasten vertical track assembly to opening jambs and framing with fasteners spaced not more than 24 inches (610 mm) apart.
 - 2. Hang horizontal track assembly from structural overhead framing with angles or channel hangers attached to framing by welding or bolting, or both. Provide sway bracing, diagonal bracing, and reinforcement as required for rigid installation of track and door-operating equipment.
- C. Accessibility: Install sectional doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.
- D. Power-Operated Doors: Install in accordance with UL 325.

3.3 STARTUP SERVICES

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks in accordance with manufacturer written instructions.
 - 2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

NOT FOR BID

3.4 ADJUSTING

- A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.
- B. Lubricate bearings and sliding parts as recommended by manufacturer.
- C. Adjust doors and seals to provide weather-resistant fit around entire perimeter.
- D. Touchup Painting Galvanized Material: Immediately after welding galvanized materials, clean welds and abraded galvanized surfaces and repair galvanizing to comply with ASTM A780/A780M.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner maintenance personnel to adjust, operate, and maintain sectional doors.

END OF SECTION

NOT FOR BID

SECTION 08 42 13
ALUMINUM-FRAMED ENTRANCES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior manual-swing glazed entrance doors and door sub-frame units.

B. Related Requirements:

1. Section 01 83 16 "Exterior Enclosure General Requirements" for additional requirements related to the building enclosure including but not limited to:
 - a. Performance and design requirements for the exterior building enclosure.
 - b. Coordination of Work required to complete the Exterior Enclosure.
 - c. Quality Assurance and Control procedures required for the work of the Exterior Enclosure.
 - d. Independent inspection and testing required to verify performance of the work of this section.
2. Section 08 71 00 "Door Hardware"
3. Section 08 44 13 "Glazed Aluminum Curtain Wall" for mounting entrances within curtain wall framing.
4. Section 08 80 10 "Exterior Glazing" for glazing of the work of this section.

1.2 REFERENCES

- A. Definitions:** Refer to Division 01 Section 01 83 16 "Exterior Enclosure General Requirements" for definitions related to Exterior Enclosure.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:** Coordinate work of this section with adjacent components of the exterior enclosure. Participate in coordination required in Division 01 Section 01 83 16 "Exterior Enclosure General Requirements".
- B. Preinstallation Meetings:**

1. Preinstallation Conference: Conduct conference at Project site.
2. In addition to requirements specified in Division 01 Section 01 31 00 "Project Management and Coordination," include the following:
 - C. Exterior Enclosure Coordination Workshops: Participate in workshops indicated in Division 01 Section 01 43 25 "Exterior Enclosure Performance Requirements."
 - D. Sequencing / Scheduling: Comply with requirements specified in Division 1 Section 01 43 25 "Exterior Enclosure Performance Requirements".

1.4 SUBMITTALS REQUIREMENTS

- A. Submit per the requirements of Section 01 33 00 Submittal Procedures and as indicated herein.
- B. Product Data for Credit MRc3: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
 1. Provide Product Data for MRc3: For products sourced (Extracted, manufactured, and purchased) within 100 miles of the project site, provide documentation indicating source location for each raw material. Include a statement indicating distance to project site, the cost of each regional material by weight that is considered regional.
 2. CM shall coordinate submittals as indicated in 018316 Paragraph 1.3-C and as otherwise indicated.
- C. Submit the following in a single complete package, Partial submittal packages shall be rejected without action.
 1. Product data
 2. Shop drawings
 3. Entrance Door Hardware Schedule and Cut Sheets
 4. Qualification data
 5. Energy performance certificates
 6. Product test reports
 7. Manufacturers certificates
 8. Fabricator certificates
 9. Installation instructions
 10. Sample Warranties

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

2. Include product data for all hardware.
- B. Sustainable Design Submittals:
1. Product Data for MRc2: Provide an Environmental Product Declarations which conform to ISO 14025 and EN 15804 or ISO 21930 and have at least a cradle to gate scope.
 2. Product Data for Credit MRc3: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
- C. Shop Drawings: For aluminum-framed entrances. Include plans, elevations, sections, full-size details, and attachments to other work.
1. Coordinate shop drawings for entrances with shop drawings for unitized curtain wall.
 2. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
 3. Include full-size isometric details of each vertical-to-horizontal intersection of aluminum-framed entrances, showing the following:
 - a. Joinery, including concealed welds.
 - b. Anchorage.
 - c. Expansion provisions.
 - d. Glazing.
 - e. Flashing and drainage.
 4. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
 5. Show each piece of hardware on the elevations and details for coordination and to ensure adequate space.
 6. Show fabricated threshold including access panels, welds, and anchor locations.
- 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 and Cut Sheets. Develop schedule for door hardware for entrances as specified in Section 08 71 00. Provide cut sheets for each piece of hardware related to entrance doors.

1.6 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For aluminum-framed entrances.
- B. Installation Instructions
- C. Field quality-control reports.
- D. Sample Warranties: For special warranties.

1.7 CLOSEOUT SUBMITTALS

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

1.8 QUALITY ASSURANCE

- A. Comply with requirements for aluminum curtain wall.

1.9 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace components of aluminum-framed entrances that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
- B. Comply with performance criteria indicated in Section 01 83 16 "Exterior Enclosure General Requirements", applicable criteria in 084413 "Glazed Aluminum Unitized Curtain Wall" and additional criteria indicated herein.

- C. Air Infiltration: Test according to ASTM E 283 for infiltration: Maximum air leakage of 1.0 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..
- D. Energy Performance: Certify and label energy performance according to NFRC as follows:
 - 1. Thermal Transmittance (U-factor): Operable door areas shall have U-factor of not more than 0.55 Btu/sq. ft. x h x deg F as determined according to NFRC 100.
 - 2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.25 as determined according to NFRC 200.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with indicated criteria, same as manufacturer of aluminum unitized curtain wall or as recommended by manufacturer of unitized curtain wall.

2.3 ENTRANCE DOOR SYSTEMS

- A. Entrance Doors: Thermally broken aluminum entrance door for manual-swing operation.
 - 1. Basis of Design: Kawneer 350/500 Heavy Wall Entrances
 - 2. Door Construction: 2-inch minimum overall thickness and 3/16" minimum wall thickness, with extruded-aluminum tubular rail and stile members with thermal breaks. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded.
 - 3. Door Design: Wide stile; 5-inch nominal width and 10" bottom rail.
 - 4. Frame Stops: Square, snap-on, extruded-aluminum stops to trim edge of frame.
- B. Framing Members: Curtain wall framing members specified elsewhere.
- C. Sub-frame Members: Thermally broken extruded aluminum sub-frame for glazing into main curtain wall frame and to accept door hardware.
 - 1. Provide removable stop to conceal mechanical fasteners.
 - 2. Provide weatherstripping at stop.
 - 3. Thickness of materials as needed for structural performance.
- D. Brackets and Reinforcements: High-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- E. Materials:
 - 1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

- a. Sheet and Plate: ASTM B 209.
 - b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
 - c. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
 - d. Structural Profiles: ASTM B 308/B 308M.
2. 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.
- a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
 - b. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
 - c. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

2.4 ENTRANCE DOOR HARDWARE

- A. Entrance Door Hardware: Hardware not specified in this Section is specified in Section 08 71 00 "Door Hardware."
- B. Weatherstripping: Double line of gaskets at jambs and head.
 - 1. Inner gasket
 - 2. Outer gasket/stop
- C. Door bottom Sweeps: Gaskets with concealed fastener aluminum extrusions on both sides of door.
- D. Threshold: Extruded aluminum offset plate, flush with finished floor on interior, maximum 1/2" rise for exterior, ADA compliant, provide return miters on cut ends. Weld together floor plate and nosing pieces to form threshold to size indicated.

2.5 GLAZING

- A. Glazing: Comply with Section 08 80 10 "Exterior Glazing."
- B. Glazing shall be a 1" fully tempered IGU.

2.6 ACCESSORIES

- A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
 - 1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 - 2. Reinforce members as required to receive fastener threads.
 - 3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.
- B. Concealed Flashing: Dead-soft, 0.018-inch- thick stainless steel, ASTM A 240/A 240M of type recommended by manufacturer
- 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.

2.7 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Physical and thermal isolation of glazing from framing members.
 - 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 5. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Entrance Door Sub-Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
- E. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
 - 1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
 - 2. At exterior doors, provide double line of weather sweeps applied to door bottoms.
- F. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.

- G. Fabricate sub-frame and entrance at fabrication plant to the greatest extent possible.
- H. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.8 ALUMINUM FINISHES

- A. Match adjacent curtain wall finishes and color for interior and exterior surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Prepare surfaces that are in contact with structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

3.3 INSTALLATION

- A. General:
 - 1. Comply with manufacturer's written instructions.
 - 2. Do not install damaged components.
 - 3. Fit joints to produce hairline joints free of burrs and distortion.
 - 4. Rigidly secure nonmovement joints.
 - 5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
 - 6. Seal perimeter and other joints watertight unless otherwise indicated.
- B. Metal Protection:
 - 1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or installing nonconductive spacers.
 - 2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

- C. Set continuous sill members, thresholds and flashing in full sealant bed as specified in Section 07 92 00 "Joint Sealants" to produce weathertight installation.
- D. Install components plumb and true in alignment with established lines and grades.
- E. Install glazing as specified in Section 08 80 10 "Exterior Glazing."
- F. 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: Complete hardware installation.

END OF SECTION

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SECTION 08 43 13

GLAZED ALUMINUM STOREFRONT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: Stick-built glazed aluminum storefront assemblies including but not limited to:
1. Glazed aluminum storefront system on the exterior of the new building for punched openings.
 2. Interior glazed aluminum storefront used as storm windows on the existing courthouse.
 3. Glazed aluminum storefront system used on the existing building for
 4. Exterior Aluminum Trim including but not limited to:
 - a. Extruded Aluminum sill pan with end dams.
 - b. Extruded Aluminum Two-piece snap on trim.
 - c. Extruded Aluminum strap anchors.
 - d. Extruded Aluminum thermally broken flat fillers.
 - e. Any item labeled "Brake Metal" on the exterior of the building and not otherwise specified.
 - f. Other exterior aluminum items identified on the drawings and not specified elsewhere.
 5. Interior Aluminum Trim including but not limited to:
 - a. Extruded Aluminum Two-piece snap on trim.
 - b. Any item labeled "Brake Metal" on the interior of the building and not otherwise specified.
 - c. Other exterior aluminum items identified on the drawings and not specified elsewhere.
 6. Accessories as shown or as may be required in conjunction with the system or to join the system to adjacent construction including but not limited to:
 - a. Reinforcing

- b. Furnishing of anchors, inserts and brackets and similar devices for embedment in concrete or welding to structural steel.
 - c. Insulation within storefront.
 - d. Engineered anchors, brackets, bolts, fasteners and miscellaneous framing to support systems.
 - e. Flashing, sealants, gaskets, backers, bond breakers and accessories.
 - 7. Pre-Construction Mockup (PMU): Provide storefront for PMU indicated in Section 014325.
 - 8. Engineering, management, coordination, submittals and other similar tasks including but not limited to:
 - a. Quality Management
 - b. Pre-installation conferences and coordination workshops.
 - c. Delegated Design of the scope of work of this section including signed and sealed engineering calculations and shop drawings.
 - d. Scheduling and monitoring of the work.
 - e. Submittals, shop drawings, erection drawings, samples and conformance test data.
 - f. Storage, shipping and handling.
 - g. Temporary Protection and cleaning.
 - h. Inspection and field measurements of adjacent and/or supporting construction.
 - i. Warranties
- B. Related Requirements:
- 1. Section 014325 "Exterior Enclosure Pre-Construction Mockup.
 - 2. Section 014525 "Exterior Enclosure Testing"
 - 3. Section 018316 "Exterior Enclosure General Requirements" for additional requirements related to the building enclosure including but not limited to:
 - a. Performance and design requirements for the exterior building enclosure.
 - b. Coordination of Work required to complete the Exterior Enclosure.
 - c. Quality Assurance and Control procedures required for the work of the Exterior Enclosure.

4. Division 7 sections for Air Barriers/Water Resistant Barriers on walls adjacent to storefront.
5. Section 088010 "Exterior Glazing" for glazing of the work of this section.

1.2 REFERENCES

- A. Definitions: Refer to Division 01 Section "Exterior Enclosure General Requirements" for definitions related to Exterior Enclosure.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate work of this section with adjacent components of the exterior enclosure. Participate in coordination required in Division 01 Section "Exterior Enclosure General Requirements".
 1. Coordinate with CFMF specified in Division 05 for loads from storefront applied to the CFMF and for rough openings.
 2. Coordinate with adjacent air barriers, waterproofing and roofing specified in Division 07.
 3. Coordinate glass and glazing specified in 088010.
- B. Preinstallation Meetings: Conduct as specified in Section 018316, Exterior Enclosure General Requirements.
 1. Preinstallation Conference: Conduct conference at Project site.
- C. Exterior Enclosure Coordination Workshops: Participate in workshops indicated in Division 01 Section "Exterior Enclosure General Requirements."
- D. Sequencing / Scheduling: Comply with requirements specified in Division 1 Section "Exterior Enclosure General Requirements".

1.4 SUBMITTAL REQUIREMENTS

- A. Submit per the requirements of Section 013300 Submittal Procedures and as indicated herein.
- B. CM shall coordinate submittals as indicated in 018316 Paragraph 1.3-C and as otherwise indicated.
- C. Coordinate with submittals for 088010 which shall be submitted at the same time as the work of this section.
- D. Unofficial Submittals: Architect may choose, at their sole discretion, to review "draft", "preliminary" or other similar submittals prior to official packages in order to assist in delivery of the work. Such unofficial submittals shall not be entered into submittal logs

and shall not require official response from Architect. Unofficial submittals shall not be submitted as an RFI and will be returned without action if done so.

E. Organization of Packages:

1. Complete scope of storefront shall be submitted in not more than 2 packages for the full scope of storefront work. Descriptions of portions of work for packages are preliminary, ensure that full scope is included.
 - a. Storefront for pre-construction mockup.
 - b. Storefront for all remaining work.
2. Shop drawings for each package shall be complete and stand alone for the scope of work in that package. Reference to details in other packages shall not be allowed.

F. Submittal for the mockup package shall include the following. A mock-up submittal packages that do not include the full list below shall be rejected without action.

1. Product data
2. NFRC CMA Certificate or alternate energy code compliance documentation.
3. Shop drawings for scope of mockup
4. Delegated design submittal for scope of mockup.
5. Energy performance certificates
6. Product test reports
7. Sustainability submittals
8. Manufacturers certificates
9. Fabricator certificates
10. Installation instructions
11. Re-glazing methodology
12. Sample Warranties

G. Submittals for the remainder of packages shall include the following. Submittal packages that do not include the full list below shall be rejected without action.

1. Product data but only for new products used in the new package.
2. Shop drawings
3. Delegated design submittal for scope of package.

H. Changes to any previous submittal discovered through preparation of submittals for subsequent packages shall require a revision to the original submittal materials.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product and material used.

- B. NFRC Certificate: Submit copy of NFRC label or CMA label certificate indicating products are tested, certified and labeled by NFRC under Component Modeling Approach.
- C. Shop Drawings: Show fabrication and installation details, materials, dimensions, gauges, trim, fasteners, closures and finishing including all attachments and joint sealants to surrounding construction. Show how system complies with specified criteria including, but not limited to accommodation of structural movement, pressure equalization, thermal cycling and control of water penetration, air infiltration and vapor migration.
 - 1. Elevations and Plans: Minimum 1/4 inch equals 1 foot scale elevation of each area of storefront.
 - 2. Typical Storefront Type Drawings: Minimum 1 inch equals 1 foot scale elevation of each typical storefront type.
 - 3. Details: Full size details of each assembly including heads, sills, mullions, corners, intersection with abutting construction and joints in system.
 - a. Include details of each different condition within the storefront system and where the storefront system abuts adjacent construction.
 - b. Include details cut through the end of tubular sections showing for example, closure, sealant backup, continuity of seals and anchorage at locations including but not limited to the intersection of vertical mullions with floor or threshold at doors; and at Tee, X or Ell intersections.
 - c. Include details cut through the ends and joints of brake metal or similar sheet fabrications showing returns, attached angles or other methods for support of sealant or connection to adjacent construction.
 - d. Show hardware at doors.
 - 4. Show sufficient information to trace continuity of inner and outer line of seals, (rain screen and air barrier), to trace line of thermal barrier and to trace continuity of vapor retarder if location differs from inner seal.
 - 5. Show membrane flashing air barrier tie-in at perimeter of the storefront connected to the air barrier/water resistive barrier in the wall.
 - 6. Where showing adjacent work such as metal panels, stone cladding, fiber cement, or other work adjacent to storefront indicate the actual shop drawing profiles of that work.
 - 7. Show joint locations in all linear including but not limited to the base flashings, and trim.
 - 8. Shop drawings shall identify every internal gasket and sealant required for indicated performance. Gaskets and sealants cannot be indicated as "by others".
 - 9. Shop drawings shall identify every anchor, bolt, screw, clip, fastener or similar device for fixing the storefront in place. These cannot be indicated as "By others".
 - 10. Extent of Shop Drawings shall be sufficient to demonstrate compliance with indicated criteria.

11. Shop Drawings shall be prepared directly by the manufacturer with manufacturer's logo and bearing the name and contact information and signature of manufacturer's design engineer.
 - a. Shop drawings may be prepared by licensed or otherwise approved installers or fabricators, and shall be accompanied by a certification letter on manufacturers letterhead, signed by manufacturers design engineer, stating that the manufacturers engineering department has reviewed the shop drawings and Contract Documents and verifies that systems represented in the shop drawings are compliant with manufacturers recommendations, contain sufficient detail to direct construction in compliance with manufacturers recommendations, are suitable for intended application and that the shop drawings are of a level of quality and completeness as if the manufacturer prepared the shop drawings themselves.
12. Shop drawings shall be updated after successful completion of the Pre-Construction Mockup testing incorporating every adjustment, repair, addition or other change made to the PMU during the testing protocol. Identify changes.

1.6 DELEGATED DESIGN SUBMITTALS

- A. Delegated-Design Submittal: For glazed aluminum 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. Calculation sheets shall be cross-referenced to the exact shop drawing page number and detail for the assembly being analyzed.
 2. Anchors: Include analysis of the anchors which attach the systems to adjacent construction or structure. Analyze and identify every anchor, bolt, screw, clip, fastener or similar device for fixing the storefront in place. These cannot be indicated as "By others".
 - a. Delegated Design Engineer shall indicate selection of proprietary anchors including but not limited to embedded slot anchors, cast-in anchors, chemical anchors, undercut anchors, and wedge anchors based on manufacturers test data and requirements for loading.
 3. Include analysis of portions of storefront 42" or less above finished floor for requirements for guards.
 4. Include thermal analysis of movement to be accommodated.
 5. Include structural analysis of metal panels and reinforcing.

1.7 INFORMATIONAL SUBMITTALS

- A. Energy Performance Certificates: Submit copies of labels with NFRC-certified energy performance values from manufacturer or documentation of alternate approval for code authority.

- B. Product test reports. Provide reports in addition to the PMU test report showing compliance with specified criteria.
1. Test reports shall be complete with shop drawing of the tested assembly.
 2. Test reports must be for a system substantially identical to the system proposed for this project including accessories.
- C. Manufacturer Certificates: Signed by manufacturer certifying that storefront system complies with the following.
1. Compliance with requirements of Division 01 Sections "Exterior Enclosure General Requirements" for a drained cavity or pressure-equalized system.
 2. Certify compliance with performance requirements.
 3. Certify that materials are appropriate for indicated use and substrates and adjacent materials are compatible.
 4. Certify Manufacturer's approval of Installer qualifications.
 5. Certify single source responsibility.
 6. Certify acceptability to manufacturer of products specified in or required by this Section that are not produced by the manufacturer who submits this Certification including but not limited to:
 - a. Internal sealants and gaskets.
 - b. Screws, bolts, anchors, clips, and similar devices.
 - c. Glass and glazing
 - d. Insulation
 - e. Silicone Membrane Air Barrier Tie-in.
 7. Certify that system/assembly depicted in Shop Drawings and other submittals, when and if installed as detailed, will result in performance substantially the same as it did in the tests on which the manufacturer bases their predictions of performance for air and water resistance, thermal performance, condensation resistance, structural capacity and other salient performance criteria in compliance with the Contract Documents. Include the primary products, all accessories, interface and anchorage to adjacent construction and all other work of this Section included in the submittals.
 8. Glass and Glazing Certificates: Coordinate with certificates indicated in 088010 for Exterior Glazing. Certify that storefront manufacturer has studied glass manufacturers requirements and incorporated into the work.
- D. Installation Instructions: Manufacturer's installation instructions.
- E. Re-glazing Methodology: Instructions for re-glazing of structural silicone glazing and standard glazing in the field to replace broken glass.
- F. Field quality-control reports.

- G. Monthly progress redlines of as-built shop drawings.
- H. Sample warranties.

1.8 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Manual: One bound copy and one electronic file (pdf) of a maintenance manual describing the various materials, equipment and procedures for cleaning and maintaining the work of this Section. Include the manufacturer's data for all components of each glazing system and type, with supplier/source and contact information. Provide replacement procedures, replacement components and methods of replacement of damaged components of glazed aluminum storefront to ensure full service capability of the work.
- B. Final executed system guarantees and warranties.

1.9 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer capable of fabricating glazed aluminum storefronts that meet or exceed performance requirements indicated and of documenting this performance by certification, labeling, and inclusion in lists.
 - 1. Experience: Minimum five (5) years producing products similar to those required for this Project. Provided products for three (3) projects of scope, schedule and complexity similar to this Project within last two (2) years as acceptable to Architect.
 - 2. Single Source Requirements: Products shall be supplied by one (1) manufacturer. Accessory products including, for example, fasteners, sealants and anchors may be from other than primary manufacturer if approved in writing by primary manufacturer and Architect.
- B. Delegated Design Engineer: Professional Engineer, licensed in State of Delaware and having a minimum of five (5) years documented experience designing systems similar to those required for this Project.
 - 1. Delegated Design Engineer shall sign and seal calculations.
 - 2. Delegated Design Engineer's scope shall include everything indicated for delegated design submittals unless provided by manufacturers engineers. Provide multiple engineers with appropriate expertise to provide full scope of submittals if necessary.
 - 3. Delegated Design Engineer shall select proprietary anchors including but not limited to embedded slot anchors, cast-in anchors, chemical anchors, undercut anchors, and wedge anchors based on manufacturers test data and requirements for loading.
- C. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of storefront systems required for this Project.

1. Experience: Minimum five (5) years fabricating and installing products similar to those required for this Project.
 2. Completed three (3) projects of scope, schedule and complexity similar to this Project using systems similar to those required for this Project within last two (2) years as acceptable to Architect.
 3. Adequately trained by manufacturer and recommended in writing by manufacturer for type of fabrication and installation required for this Project.
- D. Referenced Requirements: Comply with requirements of the following except as modified by the Contract Documents or code. Where a suggestion or recommendation is included in the reference material, comply as if written herein as mandatory. In the event of conflict between the referenced standards and the requirements of the Contract Documents, the more stringent shall govern.
1. American Architectural Manufacturers Association (AAMA) documents:
 - a. AAMA 850 Fenestration Sealants Guide Manual
 - b. AAMA GAG-1 Glass and Glazing
 - c. AAMA TIR-A9 Metal Storefront Fasteners
 - d. AAMA TIR-A11 Maximum Allowable Deflection of Framing Systems for Building Cladding Components at Design Wind Loads
 - e. AAMA TIR-A1, Sound Control for Fenestration Products
 - f. "Voluntary Guide Specifications for Structural Glazing
 2. "Aluminum Design Manual" and "Aluminum Standards and Data" issued by the Aluminum Association (AA).
 3. Code for Welding in Building Construction" issued by the American Welding Society (AWS), including but not limited to:
 - a. AWS D1.1 Structural Welding Code – Steel.
 - b. AWS D1.2 Structural Welding Code – Aluminum.
 - c. AWS D1.3 Structural Welding Code – Sheet Steel
 - d. AWS D1.4 Structural Welding Code – Stainless Steel
 4. American National Standards Institute (ANSI),
 - a. ANSI Z97.1 American National Standard For Safety Glazing Materials Used in Buildings - Safety
 5. Glass Association of North America Glazing Manual (GANA):
 - a. "Glazing Manual"

- b. "Laminated Glass Design Guide"
 - 6. Sealant and Waterproofing Institute (SWRI): "Sealant, Waterproofing and Restoration Institute: Sealants: The Professional's Guide".
 - 7. Insulating Glass Manufacturer's Alliance (IGMA): IGMA TM-3000 North American Glazing Guidelines for Sealed Insulating Glass for Commercial and Residential Use.
 - 8. National Association of Architectural Metal Manufacturers (NAAMM): "Metal Finishes Manual for Architectural and Metal Products"
 - 9. The specified standards issued by the Structural Steel Painting Council (SSPC).
 - 10. The specified documents of the Consumer Products Safety Commission (CPSC).
 - 11. Guidelines of the Glass Architectural Spray Coaters Association (ASCA).
 - 12. The "Architectural Sheet Metal Manual" published by the Sheet Metal and Air Conditioning Contractor's National Association (SMACNA).
 - 13. The hardware finish designations of the Building Hardware Manufacturers Association (BHMA).
 - 14. National Fenestration Registration Council (NFRC):
 - a. NFRC 100 Procedure for Determining Fenestration Product U-Factors.
 - b. NFRC 200 Procedure for Determining Fenestration Product Solar Heat Gain Coefficient.
 - c. NFRC Simulation Manual.
 - 15. CPSC 16 CFR, Part 1201-03, Safety Standards for Architectural Glazing,
 - E. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
 - 1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.
 - F. Storefront Quality Control Program: Establish and administer a quality control program to ensure compliance with requirements. Glazing Quality Control Program shall be incorporated into Quality Control Program specified in Division 1 Section "Exterior Enclosure General Requirements":
- 1.10 PRECONSTRUCTION PERFORMANCE AND AESTHETIC MOCKUPS (PMU)
- A. Mockups: Provide storefront elements for mockups specified in Section 014325 "Exterior Enclosure Performance Mockup" to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockup of typical wall area as shown on Drawings.
2. Testing shall be performed on mockups according to requirements in Section 014325 "Exterior Enclosure Performance Mockup".
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless contractor specifically identifies deviations and Architect specifically approves such deviations in writing.

1.11 DELIVERY, HANDLING AND STORAGE

- A. Protect prefinished surfaces with wrapping or strippable coating. Do not use adhesives which bond or leave a residue.
- B. Ship and store under conditions which will not have a deleterious effect on the finished work.'
- C. Protect during shipping and storing to eliminate water entering through weeps and from standing inside panel. Shipping panels flat is not allowed.
- D. Attach sticker, tag or other identification to each panel as identified on shop drawings.

1.12 WARRANTY

- A. Special Assembly Warranty: Manufacturer, fabricator, and installer agrees to furnish labor and material to repair or replace components of glazed aluminum storefront that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Noise or vibration created by wind and thermal and structural movements.
 - c. Failure of system to meet performance requirements.
 - d. Failure of operating components to function normally.
 - e. Loosening or weakening of fasteners, attachments, hardware and other components.
 - f. Water leakage.
 - g. Deterioration, fading, excessive non-uniformity, pitting, cracking, peeling, crazing or discoloration of finishes and other materials beyond normal weathering.

NOT FOR BID

- h. Loss of effective glass bite due to shifting of glass or loss of effective glass bearing of setting blocks due to shifting of glass and/or blocks.
 - i. Adhesive or cohesive sealant failures or crazing on surface of sealant.
 - j. Gaskets or weather strips hardening, discoloration or disengagement.
 - k. Collapse, slumping or loosening of support of thermal insulation or fire safing insulation.
- 2. Include labor necessary to remove and replace glass and glazing specified in Section 080010.
- 3. Warranty Period: Two years from date of Substantial Completion.
- B. Special Finish Warranty (Exterior Surfaces): Standard form in which coating manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Warranty Period: 20 years for AAMA 2605 finish, and 5 years for other finishes from date of Substantial Completion.
- C. Special Finish Warranty (Interior Surfaces): Standard form in which coating manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period when used on the interior of the building.
 - 1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Warranty Period: 10 years for AAMA 2603 finish from date of Substantial Completion for surfaces exposed to interior conditions only.

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PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design unitized aluminum storefront system with all accessories included in this specification section.
 - 1. Design each anchor bolt, screw or other device to attach work of this section to adjacent construction.
 - 2. Services shall include but not be limited to those identified for required delegated design submittals.
- B. General Performance: Comply with performance requirements specified, as determined by testing of glazed aluminum storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
 - 1. Comply with performance criteria indicated in Section 018316 "Exterior Enclosure General Requirements" and additional criteria indicated herein.
 - 2. Glazed aluminum storefronts shall withstand indicated movements of supporting structure.
 - 3. Failure also includes the following:
 - a. Thermal stresses transferring to building structure.
 - b. Glass breakage resulting from manufacturing, fabrication, or installation defect. Glass breakage by others is excluded.
 - 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. Performance Mockup and Preconstruction Testing: Provide a glazed aluminum storefront which successfully completes testing protocol specified in 014325 "Exterior Enclosure Performance Mockup" in addition to all criteria listed in this section.
- D. Structural Loads:
 - 1. Loads: Comply ASCE 7 for cladding and components and with loads indicated on S-001.
 - 2. Maintenance Loads: 300 pounds at any one square foot area or any 1 foot length of a surface less than 1 foot wide and more than 45 degrees off vertical and more than 4" wide, interior and exterior. Load shall not be considered concurrent with any other load criteria. Deflection shall be limited to not result in permanent set or to exceed elastic limits of materials.

3. Interior window sills and stools: Comply with requirements for Maintenance Loads.

E. Structural Requirements at Design Load:

1. General:
 - a. Either allowable stress design (ASD) and load and resistance factor design (LRFD) are acceptable.
 - b. For allowable stress design, allowable stress shall not be increased for individual loads or load combinations.
 - c. Applicable loads shall be considered in accordance with the load combinations specified by the codes. Effects from one or more transient loads not acting shall be considered.
 - d. Design brackets and welded anchors to carry 2 times the self-weight without causing overstress or slipping of anchors.
2. Deflection of any member in a direction normal or perpendicular to plane of wall when subjected to design loads shall not:
 - a. Exceed limits in Publication No. AAMA TIR-A11, Maximum Allowable Deflection of Framing Systems for Building Cladding Components at Design Wind Loads, when member supports only glass or glass and metal spandrel panels as follows: "At design wind loads, deflections of building cladding members for spans up to 13'-6" shall be limited to L/175. For spans greater than 13'-6", but less than 40 feet, deflections at design wind loads shall be limited to the more conservative value of L/240 plus 1/4 inch.
 - b. For the face of metal panels deflection shall be value as required to eliminate visible oil canning as defined in Section 018316.
 - c. Exceed the indicated deflection limits above at two times the length of a cantilevered framing member.
 - d. Deflection of vertical mullions supporting sunshades shall be determined by the combined live and dead loading of sunshade and lateral wind loads simultaneously.
3. Thermally broken members: Meet specified criteria and minimum certified testing criteria and procedures as described by the AAMA TIR-A8 performance standards.
4. Deflection of any member in a direction parallel to face of glazing when subjected to design loads shall not:
 - a. Exceed L/360 of clear span

- b. Exceed amount which reduces glazing bite to less than 75 percent of design dimension.
 - c. Exceed amount which reduces edge clearances between framing members and glazing below edge clearances required to accommodate movements.
 - d. Exceed $\frac{1}{4}$: for spans up to 16 feet or $\frac{3}{8}$ " for spans greater than 16 feet for corner mullions.
- 5. Net deflection parallel and perpendicular to enclosure surface for framing members at perimeter sealant joints shall not exceed smallest of: values specified above, 50 percent of joint width, or movement capacity of sealant.
 - 6. Twisting (rotation) of horizontal members due to the weight of the glass should not exceed 1 degree measured between ends and center of each span.
 - 7. Deflection of sheet metal shadow boxes and backpans: limited to $L/60$ and maximum $\frac{3}{4}$ inch, except less if required to noise from movement or detrimental effect on the performance of system.
 - 8. The anticipated movement of the framing members must not exceed the movement capabilities of adjoining sealants.
 - 9. The movement of the framing members must not cause disengagement of applied snap covers or trim.
 - 10. The design of the framing members must accommodate differential movement in adjacent framing members such as might occur at jambs, parapets, unusual geometries and other similar conditions.
 - 11. The framing members must be able to resist any secondary bending moments resulting from axial loads acting through eccentricities caused by large deflections, such as, P-Delta effects.
 - 12. In order to prevent disengagement of the infill material, design of systems incorporating large infill panels must also address the center deflection of the infill panels in conjunction with the framing deflection.
 - 13. Where various exterior enclosure systems are interconnected, design all systems for the most restrictive individual system deflection criteria or provide for adequate flexibility within the connections to allow differential deflection without adversely affecting any of the connected systems.
 - 14. Glass Deflection:
 - a. Limit deflection of glass supported on 4 sides normal to its plane at full design load to lesser of $L/50$ of short span or 1 inch, whichever is less.
 - b. Limit deflection of cantilevered glass supported on one edge to 1" under guard rail loading without windload.
 - c. Limit deflection of cantilevered glass supported on one edge to $L/25$ under wind loading.
 - d. Limit deflection if necessary so glass does not deflect to the point of contacting adjacent construction.

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- e. Limit glass deflection to not cause stresses that could result in early failure, deterioration or cause to void warranty. Manufacturer shall certify that design does not cause undue pressure in glass as placed and designed.
 - f. Limit deflection of glass supporting members when carrying full design load so not to reduce glass bite below 75 percent of design dimension. Member shall have a 1/8 inch minimum clearance between itself and edge of fixed panel, glass or fixed part immediately adjacent and shall not impair function of or damage any joint seals when deflected.
- 15. Stresses shall not exceed allowable values established by Specifications.
 - 16. Glass and structural silicone sealant shall not be assumed to contribute to framing member strength, stiffness or lateral stability without specific analysis by delegated design engineer and inclusion of recommendations of silicone sealant manufacturer.
 - 17. Interior finishes including gypsum wallboard shall not be assumed to contribute to framing member strength, stiffness or lateral stability.
 - 18. Compression flanges of flexural members may be assumed to receive effective lateral bracing only from members in actual contact with compression flange and adequately anchored to building structure. Points of contraflexure shall not be regarded as lateral braces or as end points of an unbraced length; unbraced length shall be actual distance between effective lateral braces as defined above.
 - 19. Design exterior panel connections for 1.33 times lateral seismic force, and with sufficient ductility and rotational capacity to preclude brittle failure. Fasteners attaching connector to panel or structure, such as bolts, inserts, welds, dowels and similar fasteners, shall be designed to ensure ductile behavior of connector or shall be designed for four (4) times lateral seismic force. Fasteners embedded in concrete shall be attached to or hooked around reinforcement, or shall be otherwise terminated so as to effectively transfer seismic force to reinforcement.
 - 20. Limit deflection as required to not adversely affect performance for water penetration, air leakage and other similar specified criteria.
 - 21. Limit deflection as required to control oil canning.
- F. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:
- 1. Fixed Framing and Glass Areas: 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 10 lbs/sq. ft..
 - 2. Criteria for water infiltration testing is for no uncontrolled water as defined in Section 018316.
- H. Water Penetration under Dynamic Pressure: Test according to AAMA 501.1 as follows:
- 1. No evidence of water penetration through fixed glazing and framing areas when tested at 10 lbf/sq. ft.

2. Criteria for water infiltration testing is for no uncontrolled water as defined in Section 018316.
- I. Energy Performance: Certify and label energy system performance according to NFRC as follows:
 1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than the following as determined according to NFRC 100:
 - a. At vision glass: 0.45 Btu/sq. ft. x h x deg F.
 2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.25 as determined according to NFRC 200.
 3. Values shall be determined for project specific glazing sizes.
- J. Condensation Resistance: CRF of 65 minimum.
- K. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:
 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
 2. Provide for all thermal movement in the plane of the exterior wall system without causing buckling, stress on glass, metal, or joint seals, undue stress on structural elements or glass, excess loads on fasteners, reduction of performance or other detrimental effects.
 3. Full movement allowances including assembly and installation tolerances shall be incorporated into all junction/components at each expansion joint or assembly.
- L. Movement of the Structure: Design framing system and connections to maintain clearances at openings, to allow for fabrication and construction tolerances, to accommodate live-load deflection, shrinkage and creep of primary building structure, and other building movements.
 1. Accommodate the following vertical movement of the structural frame:
 - a. Deflection of edge of slab, spandrel beams or other structural members supporting storefront: Differential vertical movement and long-term deflection after exterior façade installation plus thermal movement of storefront: **Minimum 3/4"**
 2. Accommodate the following lateral movement (drift) of the structural frame when tested per AAMA 501.4 at the following design displacement.
 - a. Resulting from wind loading: $H/400$ (H is the floor to floor height)
 - b. Resulting from seismic event: $0.015H$

3. Provide moveable joints to accommodate the full range of movement requirements including manufacturing tolerances, construction tolerances, thermal movement, lateral movement, floor sag, beam sag, live load deflection and column settlement.
4. Allowance for movement shall be in addition to allowance for building construction tolerances.
5. Joints shall accommodate the worst possible combination of erection tolerances and anticipated movements to prevent loads of any kind being transferred from the building into the glazing systems, excessive movements of any joints or failure of weather seals.
6. Design movement joint and select sealant products to accommodate all required expansion and contraction within joint tolerances indicated on the approved shop drawings and within the sealant movement limits recommended by the sealant manufacturer under loaded and unloaded conditions.
7. All movement allowances shall be consistent and applied across all junctions and/or components for each expansion joint system or assembly.
8. For design, elastic deflections due to earthquake loads shall be multiplied by the deflection amplification factor (Cd).
9. Shore, pre-load, or utilize other methods to limit or control building movements during installation.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, products by one of the following will be considered. Adapt existing systems as necessary to comply with indicated requirements.

1. YKK AP
2. Oldcastle Building Envelope, Inc
3. Wausau

2.3 SYSTEM DESCRIPTIONS

- A. Storefront Systems for New Building: Thermally broken storefront framing system.
1. Glazing Method: Glass installed from exterior with removable stops at head. Dry gasket glazed in accordance with 088010 including interior heel bead.
 2. Framing Description: 2" wide. Depth 6" with glass near front face.
 3. Framing Method: Shear Block
 4. Sill Receiver: Extruded aluminum with 2 1/2" high back leg, with gasket for air seal to mullions. Sill receiver/flashing shall be suitable for anchorage for lateral loading with strap anchors. No penetrations allowed through the bottom horizontal portion of the receiver/flashing into the subsill air barrier membrane.
 5. Frame Filler: Flush, extruded aluminum, thermally broken for perimeter between strap anchors.
 6. Air Barrier Tie-in: Suitable for membrane connection over frame filler.

7. Anchors: Extruded aluminum thermally broken strap anchors designed to engage into perimeter mullions and sill pan.
- B. Storefront Systems for use as Storm Windows on Existing Courthouse Building: Thermally broken storefront framing system.
 1. Glazing Method: Glass installed from exterior with removable stops at head. Dry gasket glazed in accordance with 088010 including interior heel bead.
 2. Framing Description: 2" wide. Depth 4 1/2" with glass centered.
 3. Framing Method: Shear Block
 4. Sill Receiver: Extruded aluminum with 2 1/2" high back leg, with gasket for air seal to mullions.
 5. Frame Filler: Flush, extruded aluminum, thermally broken for perimeter to support backer rod and sealant.
- C. Framing Members: Extruded aluminum framing members of thickness required and reinforced as required to support imposed loads.
 1. Construction: Thermally broken to comply with indicated thermal performance.
 2. Reinforcement: Reinforce the mullions internally with steel or aluminum as required to comply with performance criteria.
- D. Two (2) Stage Weatherproofing: System shall provide redundant weatherproofing (both internal to system and at interface of system with adjacent construction) to control infiltration of water which may bypass outer layers by means defined in Section 018316.
- E. All components of system that have faces exposed to both interior and exterior shall be thermally broken as required for indicated performance criteria.
- F. System shall be airtight, vapor tight and water tight at interior face of glazing and interior face of glazing pocket at vision glass and a backpan at shadow boxes to performance criteria indicated.
- G. Systems which require blind seals, seals that cannot be tooled in their final location, seals with 3 sided adhesion at movement joints, seals not adequate to accommodate required movement or other seals which do not comply with SWRI recommendations and which are required to maintain the performance of the air barrier, even if such conditions have adequately passed laboratory testing, will not be allowed.
- H. Do not allow water to puddle or stand. Surfaces shall be pitched towards drains or weeps. Provide upstand legs at upper limit to control water penetration.
- I. Air Barrier/Vapor Retarder: System shall be air tight, vapor tight and water tight at interior face of glazing and interior face of glazing pocket at vision glass.
- J. All gaskets/weather stripping/spacers shall have continuous mechanical engagement to framing members; adhesive attachment is not acceptable.

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- K. Provide filler panels along lengths of open extrusions to allow for air barrier transition membrane and to back-up of full depth of sealant and backer rod where sealant is indicated or required to meet specified criteria. Seal such filler panels if required for performance.
- L. In the ends of mullions and similar extrusions, fill cavity with compressible silicone blocks, metal plate or other device and seal air tight if required for continuity of other seals at corners and where vertical mullions intersect horizontals.
- M. Brackets and Reinforcements: High-strength aluminum with non-staining, nonferrous shims for aligning system components.
- N. Materials:
 - 1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - a. Sheet and Plate: ASTM B 209.
 - b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
 - c. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
 - d. Structural Profiles: ASTM B 308/B 308M.
 - 2. Steel Reinforcement: Coat with 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.
 - a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
 - b. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
 - c. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.
 - 3. Stainless Steel:
 - a. For shapes, plates, bars and strip (exposed): AISI Type 316, ASTM A 666.
 - b. For shapes, plates, bars and strip (concealed): AISI Type 304, ASTM A 666.
 - c. Fasteners: AISI Type 303, 304 or 316 non-magnetic.
 - 1) Bolts and screws: ASTM F 593.
 - 2) Nuts: ASTM F 594.
 - 3) Button and countersunk head screws: ASTM F 879.

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4. Aluminum Composite Material: Not allowed.

2.4 ACCESSORIES

- A. Insulation: Semi-rigid, rock or slag mineral fiber, complying with ASTM C 612, un-faced except where indicated to be foil-faced, including manufacturer's written recommended anchors, stick pins, foil-tape, sealants and accessories.
- B. Fasteners and Accessories: Corrosion-resistant, non-staining, 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. If exposed use fasteners with countersunk Phillips screw heads, finished to match framing system.
 4. Materials:
 - a. Contacting Aluminum and Dissimilar Metals: Stainless steel, ASTM F 593 and F 594, Alloy Group 1.
 - b. Contacting Steel or Galvanized Steel Only: Hot dip galvanized steel conforming with ASTM B 633, SC 4 or ASTM A 153.
 - c. Exposed to the weather or in internal cavities subject to wetting: Stainless steel, ASTM F 593 and F 594, Alloy Group 1.
- C. Silicone Membrane Flashing Sheet: Pre-extruded silicone sealant membrane by Dow, GE, Pecora or Tremco.
 1. Basis of Design: Tremco Proglaze ETA with 3D molded silicone corners.
 2. Primers, liquid-sealant, cleaning agents and accessories as recommended in writing by manufacturer.
- D. Spray Foam Insulating Sealant: Minimal expanding, polyurethane foam, classified as a sealant per UL R13655. Closed cell content minimum 80% per ASTM D 2856, Flame spread less than 25, smoke development less than 450 per ASTM E 84.
 1. Basis of Design: Dow Great Stuff Pro Window and Door or equivalent.
- E. Filters: Silicone compatible PVC-coated reticulated open cell polyurethane foam, 30 to 40 pores per 1 linear inch sized for installation at 30-50 percent compression.
 1. Provide PVC Coated SIF-G Industrial Foam by Stephenson and Lawyer, Inc or equivalent.
- F. Coatings:

1. Shop Primer for Steel: Zinc dust rich primer SSPC Paint 20 or Paint 29 Organic zinc-rich epoxy coating.
 2. Touch-up Primer for Galvanized Steel: Primer with minimum 80 percent zinc in dry film complying with SSPS 20.
 3. Dissimilar Metal Coating: Cold-applied asphalt mastic complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat or other non-conductive, non-absorptive material.
- G. Foam Tape: 9 pcf density (self-adhesive) foam tape with flame retardants to meet FMVSS 302 flammability standard. Norton V 780 or approved substitution. Provide tape 1 inch wide, unless otherwise indicated by the following thickness.
1. Provide 1/8 inch thick at metal panels, concrete or other smooth substrate.
 2. Provide 1/4 inch thick at masonry or similar rough substrate.
- H. Butyl Coated Foam Tape: Soft, compressible PVC foam core encapsulated with 100 percent solids butyl. "Norex" by Norton or approved substitution. Provide 1/8 inch by 1/2 inch tape, unless otherwise indicated.
- I. Double Stick Tape: Closed-cell foam tape for structural bonding, 3M "VHB" Tapes or approved equivalent. Minimum peel adhesion of 15 pounds per inch. Use minimum thickness tape to provide hairline joints where exposed.
1. Primers, cleaning agents and accessories as recommended in writing by tape manufacturer.
- J. Concealed Flashing: Aluminum or dead-soft, 0.018-inch- thick stainless steel, ASTM A 240/A 240M of type recommended by manufacturer.
1. Primers, cleaning agents and accessories as recommended in writing by silicone manufacturer.

2.5 ANCHORS and BRACKETS

- A. Anchors: Extruded aluminum thermally broken strap anchors designed to engage into perimeter mullions and sill pan.
- B. Provide all required anchors and brackets sufficient to properly support the storefront off the CFMF frame and other structure.
- C. Fabricate from aluminum. Provide brackets of sufficient size and structural capacity to bridge between storefront system and the framing members or adjacent structure.
1. Design anchors to be adjustable with shims, elongated holes, or other similar method.
 2. Allow for building and system movement.
 3. Accommodate fabrication and installation tolerances.
 4. Transmit load to foundation, slab edge, CFMF or structural steel in a fashion that does not exceed the capacity of the supporting element.

- D. Anchors in Concrete: Design anchors for edge clearance at concrete as required for the loading and per manufacturers recommendations.

2.6 INTERIOR TRIM AND ACCESSORIES

- A. Interior brake metal shall be aluminum, minimum wall thickness 0.125 inch", profiles as indicated on Drawings. Thickness, reinforcement and anchorage as required for indicated performance criteria
 - 1. Aluminum Composite Material: Not allowed.
- B. Where interior trim intersects with storefront or with other trim provide:
 - 1. At ends of extruded trim, cut square, de-burr and prepare for a hairline joint.
 - 2. At ends of brake metal trim, hem the edge and prepare for a hairline joint.
- C. Interior Snap-on Trim: Extruded aluminum, two-piece with concealed fasteners.

2.7 EXTERIOR TRIM AND ACCESSORIES

- A. Brake metal and other similar formed exterior trim shall be extruded aluminum, minimum wall thickness 0.125 inch" except provide 20 gage stainless steel where indicated on drawings, profiles as indicated on Drawings. Thickness, reinforcement and anchorage as required for indicated performance criteria.
 - 1. Aluminum Composite Material: Not allowed.
- B. Exterior Snap-on Trim: Extruded aluminum, two-piece with concealed fasteners.

2.8 SEALANTS (NON-STRUCTURAL)

- A. All joints sealed as part of the fabrication or erection procedure, shall be sealed with an approved silicone sealant in color selected from manufacturers standard charts to match the adjoining surfaces or as may be required by the Architect. All perimeter sealant (to adjacent construction) shall be silicone sealant specified in Section 079205.
- B. Silicone selection to be based on manufacturers recommendations and preconstruction adhesion test.
- C. Silicone sealant shall be as manufactured by Dow Corning, Pecora, Tremco or General Electric (Momentive).
- D. Glass PIB and secondary seals shall be black.
- E. Internal seals not exposed to view will be silicone as determined by the storefront manufacturer.

- F. In using specified sealants, strictly observe the printed instructions of sealant manufacturer regarding joint size, limitations, backer rod, mixing, cleaning, surface preparation, priming and application.
 - 1. A primer shall be used if recommended by the sealant manufacturer.
 - 2. Sealant shall not be applied when substrates are wet or when the temperature is below limits recommended by sealant manufacturer.
- G. Do not allow "Three Surface Adhesion" at joints subject to movement, provide bond breakers or backers. Three surface adhesion is acceptable in static joints.
- H. Contractor shall provide certification from sealant manufacturer that the sealant manufacturer has reviewed all sealant details and finds same suitable for the purpose intended, compatible with and will not stain the surfaces with which they are in contact. Statement as to compatibility, adhesion sufficiency and non-staining shall be accompanied by actual test results on production substrates performed in accordance with applicable ASTM procedures.
- I. Compatibility: ASTM C1087, Submit an overall compatibility schedule for all sealants with all contact surfaces, in spreadsheet format, with written verification attached from sealant manufacturer for same. Demonstrate that all substrates are compatible with the sealant after 21 days exposure to ultra violet, 2000 - 4000 (micro watt u.v. radiation).
- J. All non-structural silicone to be black.

2.9 GLAZING

- A. Glazing: Comply with Section 088010 "Exterior Glazing."

2.10 FABRICATION

- A. Fabricate frames to provide for minimal work on site.
- B. Fabricate storefronts so that final work will comply with indicated performance criteria matching the fabrication methods used on successfully tested systems.
- C. Form or extrude aluminum shapes before finishing.
- D. Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Physical and thermal isolation of glazing from framing members.
 - 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 5. Provisions for field replacement of glazing from interior for vision glass and exterior for spandrel glazing panels.

6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- E. Fabricate components to resist water penetration as specified.
- F. Fabricate to accommodate lighting protection system and electrical services to lighting mounted on storefront.
- G. Brake Metal Elements:
 1. Fabricate to profiles indicated and as required for performance criteria.
 2. Fold back edges or provide adhered or welded on angle at perimeter to accept sealant and backer.
 3. Fabricate back-up plates with concealed retainer clips.
 4. Reinforce to eliminate oilcanning with aluminum angles welded or adhered to back of panel.
 5. Complete welding before finishing.
 6. Fabricate anchor clips and attachments which resist loads and allow movement.
 7. At formed metal, the perimeter arris (i.e. the arris between the face plane and the edge plane) shall be consistent throughout the work. Panel sheet shall be scored and back-cut to achieve a sharp arris with a design radius not exceeding 1/16 inch.
 8. Grain of panels shall be oriented in the same direction upon installation.
 9. Panel support construction shall result in a panel visual flatness within specified tolerances.

2.11 ALUMINUM FINISHES

- A. Comply with requirements indicated in Section 018316 for Coated Metal Color Control in addition to requirements specified herein for coordination, sourcing limits, color variation tolerances, etc.
- B. General:
 1. Shop finish Work, including surfaces not to be exposed to view in Final Work.
 2. Finish aluminum to match other adjacent aluminum components.
 3. Surfaces not exposed to the exterior or the interior shall receive a chemical conversion coat pretreatment associated with organic coating. All conversion coatings shall meet the minimum requirements of ASTM B 449. Approved coatings are:
 - a. Alodine as manufactured by Amchem Products, Inc.
 - b. Bonderite as manufactured by The Parker Company.
- C. High-Performance Organic Finish:
 1. High-Performance Organic Finish (Two-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion

coating; Organic Coating: manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than **70** percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with **AAMA 2605** and with coating and resin manufacturers' written instructions.

2. Color and Gloss: Custom color to match architect's sample. Two colors required.

D. Storefront extrusions shall be finished prior to shop fabrication except any members that require welding or other fabrication that results in damage to finish or exposed surfaces (except for cut ends) and as otherwise indicated. Coat any cut ends of extrusions that may be visible in the finished work with a shop or field coating system recommended by the primary coating system manufacturer.

2.12 FABRICATION TOLERANCES

A. General: Fabricate to comply with tolerances indicated for installed work or with more stringent tolerances if required to:

1. Match approved Samples and Mock-ups.
2. Comply with performance criteria.
3. Comply with manufacturer's written instructions.
4. Align with other supported or adjacent Work with more stringent tolerances.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify dimensions, tolerances, and conditions of building structure and substrate are within specified limits.
2. Verify substrates and structure to which storefront will be anchored are suitable for method of attachment indicated in shop drawings.
3. Verify rough openings are ready to receive Work of this Section.
4. Verify accurate benchmarks and layout control points.
5. Verify that adjacent waterproofing, and air barrier/water resistive barrier to which storefront is sealed are complete and watertight, including intersection with other systems.

B. Proceed with installation only after unsatisfactory conditions have been corrected

1. Commencing installation indicates acceptance of substrates, structure and adjacent conditions.

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3.2 PREPARATION

- A. Prepare surfaces that are in contact with sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces
- B. Furnish inserts and embedded anchors to trades responsible for their installation. Direct locations of block-outs in concrete. Direct layout and verify accuracy.
- C. Furnish anchors shop welded to structural steel to trades responsible for their installation. Direct locations and verify layout and accuracy.

3.3 INSTALLATION

- A. General:
 - 1. Install storefronts so that final work will comply with indicated performance criteria matching the installation methods used on successfully tested systems.
 - 2. Install as required to match approved submittals and as required to provide performance indicated.
 - 3. Comply with manufacturer's written instructions.
 - 4. Do not install damaged components.
 - 5. Fit joints to produce hairline joints free of burrs and distortion.
 - 6. Rigidly secure nonmovement joints.
 - 7. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
 - 8. Where welding is required, weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
 - 9. Seal joints watertight unless otherwise indicated.
- B. Sub-Sill: Install with strap anchors and shims with no penetrations allowed into the air barrier transition membrane below. Provide watertight end dams.
- C. Metal Protection:
 - 1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
 - 2. Where aluminum is in contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint or other method acceptable to architect.
- D. Anchors and Connections:
 - 1. Anchors and connections shall be provided to fully satisfy their required purpose of adjustability, movement, and load transfer.
 - 2. Connections between different materials shall be designed to allow for the differential thermal movement of the respected materials.

3. Anchors and connections that are not designed to provide for movement shall prevent such movement by appropriate means.
 4. Anchors and connections that are designed for movement shall be of such construction that friction is low enough to allow for such movement without buckling and other damage and without causing binding and noises.
 5. Self-drilling, self-threading fasteners shall not be permitted for use into concrete or masonry.
 6. Metal surfaces shall be separated in such a manner that metal does not move on metal. Materials used for this purpose shall be low friction components, sealants or gaskets as applicable.
 7. Anchorages to Structural Steel shall not induce rotational forces in supporting members.
 8. All anchors, connections, and fixings outboard of the air-seal shall be 300 series stainless steel.
 9. Avoid excess shimming that may induce additional stress on fasteners. The total thickness (t) of a shim pack shall not exceed a dimension equal to the diameter (d) of the fastener/anchor. Where $t > d$, the fastener/anchor shall be recalculated to take into account the additional stress from bending on the fastener with the assumption that the shim does not contribute to resistance to fastener bending. Additional stress due to bending shall be added to tension stress and the tension/shear interaction analyzed
 10. Shim packs that resist compressive forces only may be high-impact plastic, Korolath type or equal. Shim packs subject to shear forces shall be stainless steel or HDG steel plates pinned together to form a monolithic shim.
- E. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum storefront to exterior.
- F. Install components plumb and true in alignment with established lines and grades.
- G. Install glazing as specified in Section 088010 "Exterior Glazing."
1. Install glass with low-e coatings in proper orientation.
 2. Install with fill tubes for IGU at the top of the panel.
 3. Install glass from exterior side.
- H. Install aluminum entrance doors specified elsewhere in Division 8 that are mounted into the storefront.
- I. Joint Sealants and Joint Fillers: Refer to Joint Sealants: Division 7.

3.4 FIELD QUALITY CONTROL

- A. Provide daily inspection of installation per approved Storefront Quality Program.
- B. Field Testing is specified in Section 014525. Cooperate with testing agency and provide access.

1. Glazed aluminum storefronts will be considered defective if they do not pass tests and inspections.
- C. Comply with requirements of Division 01 Section "Exterior Enclosure General Requirements" for Quality Assurance and Control procedures required for the work of the Exterior Enclosure.
- D. Installation Tolerances:
 1. General: Install to tolerances as required to:
 - a. Comply with tolerances indicated in Section 018316.
 - b. Match approved Mockup and Samples.
 - c. Comply with performance criteria.
 - d. Comply with manufacturer's written instructions.
 - e. Achieve tolerances indicated for Final Work.
 2. Localized Bow and Warp of glass and IGU Panes glazed into or mounted on storefront frames installed in the finished work: Glass, IGU and metal panels shall be free of bow and warp to limit visual distortion to not exceed aesthetic standards established with samples and mockups. In no case shall the tolerance for localized bow and warp exceed the lesser of the following:
 - a. 1/32" over any 12"
 - b. 5:1000 along any edge
 - c. 7:1000 along a diagonal (longest if unequal).
 - d. Maximum measured bow and warp in samples and in mockups.

3.5 ADJUSTING

- A. Touchup damage to prefinished surfaces per recommendations of coating manufacturer. Touch ups shall be invisible in the finished work per definition of Surface Uniformity in Section 018316.

3.6 CLEANING

- A. Clean per manufacturers written instructions and industry standards.
- B. Clean system periodically during construction as necessary to avoid permanent damage or staining. Inspect at least monthly to ensure no permanent damage or staining.

NOT FOR BID

- C. Clean completed system, inside and out, promptly after erection and installation of glass and sealants, allowing for nominal curing of liquid sealants.
- D. Within one week before Date of Substantial Completion, clean storefront system thoroughly and polish glass, inside and out.
- E. Demonstrate proper cleaning methods and materials to Owner's maintenance personnel.

3.7 PROTECTION

- A. Protect Finished Work from damage immediately after erection.
- B. Protect aluminum with protective covering.
- C. Protect glass with crossed streamers attached to aluminum, not to glass.
- D. Protect glass per GANA TD-03-1003 at a minimum.

END OF SECTION

SECTION 08 44 13

GLAZED ALUMINUM CURTAIN WALL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: Stick-built glazed aluminum curtain wall assemblies including but not limited to:
1. Glazed aluminum curtain wall system spanning past edge of floor slab.
 2. Aluminum curtain wall framing supporting aluminum entrances.
 3. Spandrel
 4. Shadow Box over main entrance.
 5. Operable Vent for roof access.
 6. Exterior Aluminum Trim including but not limited to:
 - a. Extruded Aluminum Mullion Covers including Extension Trim and wide covers.
 - b. Any item labeled "Brake Metal" on the exterior of the building and not otherwise specified.
 - c. Other exterior aluminum items identified on the drawings and not specified elsewhere.
 7. Interior Aluminum Trim including but not limited to:
 - a. Extruded Stools and sills.
 - b. Extruded extension trim.
 - c. Any item labeled "Brake Metal" on the interior of the building and not otherwise specified.
 - d. Other interior aluminum items identified on the drawings and not specified elsewhere.
 8. Accessories as shown or as may be required in conjunction with the system or to join the system to adjacent construction including but not limited to:
 - a. Reinforcing
 - b. Furnishing of anchors, inserts and brackets and similar devices for embedment in concrete or welding to structural steel.
 - c. Insulated metal panels within curtain wall.
 - d. Insulation within curtain wall.
 - e. Back pans.
 - f. Engineered anchors, brackets, bolts, fasteners and miscellaneous framing to support systems.

- g. Flashing, sealants, gaskets, backers, bond breakers and accessories.
 - h. Silicone Membrane Transition Flashing
 - i. Filtered vents and weeps, weep tubes.
 - j. Bellows, closures, gutters, end dams, flashings, trim.
- 9. Pre-Construction Mockup (PMU): Provide curtain wall for PMU indicated in Section 01 43 25.
- 10. Engineering, management, coordination, submittals and other similar tasks including but not limited to:
 - a. Quality Management
 - b. Pre-installation conferences and coordination workshops.
 - c. Delegated Design of the scope of work of this section including signed and sealed engineering calculations and shop drawings.
 - d. Scheduling and monitoring of the work.
 - e. Insert and bracket setting diagrams.
 - f. Submittals, shop drawings, erection drawings, samples and conformance test data.
 - g. Storage, shipping and handling.
 - h. Temporary Protection and cleaning.
 - i. Inspection and field measurements of adjacent and/or supporting construction.
 - j. Warranties

B. Related Requirements:

- 1. Section 01 43 25 "Exterior Enclosure Pre-Construction Mockup.
- 2. Section 01 45 25 "Exterior Enclosure Testing"
- 3. Section 01 83 16 "Exterior Enclosure General Requirements" for additional requirements related to the building enclosure including but not limited to:
 - a. Performance and design requirements for the exterior building enclosure.
 - b. Coordination of Work required to complete the Exterior Enclosure.
 - c. Quality Assurance and Control procedures required for the work of the Exterior Enclosure.
- 4. Division 7 sections for roofing and waterproofing adjacent to and/or tied into curtain wall.
- 5. Division 7 sections for Air/Moisture Barriers on walls adjacent to curtain wall.
- 6. Section 07 42 19 "Aluminum Plate Wall Panels" for panels mounted adjacent to aluminum curtain wall.
- 7. Section 07 84 46 "Curtain Wall Joint Firestopping"
- 8. Section 08 42 13 "Aluminum Entrances" for entrance doors mounted within curtain wall framing.
- 9. Section 08 43 13 "Aluminum Storefront"
- 10. Section 08 80 10 "Exterior Glazing" for glazing of the work of this section.
- 11. Division 10 for signage mounted inside of shadow box at main entrance.

12. Division 21, 22, 23, 26, 27 and 28 sections for work penetrating or mounted on curtain wall including lighting mounted within the shadow box at main entrance.
13. Section 26 41 00 for lightning protection system.

1.2 REFERENCES

- A. Definitions: Refer to Division 01 Section 01 83 16 "Exterior Enclosure General Requirements" for definitions related to Exterior Enclosure.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate work of this section with adjacent components of the exterior enclosure. Participate in coordination required in Division 01 Section 01 83 16 "Exterior Enclosure General Requirements".
 1. Coordinate with CFMF specified in Division 05 for loads from curtain wall applied to the CFMF and for rough openings.
 2. Coordinate with adjacent air barriers, waterproofing and roofing specified in Division 07.
 3. Coordinate with work specified in the following sections for components mounted in or adjacent to curtain wall.
 - a. Section 08 42 13 "Aluminum Entrances" for entrance doors mounted within curtain wall framing.
 4. Coordinate glass and glazing specified in 08 80 10.
 5. Coordinate signage specified in Division 10 mounted in shadow box.
 6. Coordinate pipes, conduits, ducts, boxes, access panels or other components of the HVAC, Plumbing, Fire Protection, Security, Communications, or other similar systems penetrating, mounted in, mounted to, or mounted on curtain wall.
 7. Coordinate lighting fixtures, boxes, conduits, or other components of the electrical system penetrating, mounted in, mounted to, or mounted on curtain wall.
 8. Coordinate lightning protections system penetrating, mounted in, mounted to, or mounted on curtain wall.
- B. Preinstallation Meetings: Conduct as specified in Section 01 83 16, Exterior Enclosure General Requirements.
 1. Preinstallation Conference: Conduct conference at Project site.
- C. Exterior Enclosure Coordination Workshops: Participate in workshops indicated in Division 01 Section 01 83 16 "Exterior Enclosure General Requirements."
- D. Sequencing / Scheduling: Comply with requirements specified in Division 1 Section 01 83 16 "Exterior Enclosure General Requirements".

1.4 SUBMITTAL REQUIREMENTS

- A. Submit per the requirements of Section 01 33 00 Submittal Procedures and as indicated herein.
- B. Coordinate submittals as indicated in 01 83 16 Paragraph 1.3-C and as otherwise indicated.
- C. Unofficial Submittals: Architect may choose, at their sole discretion, to review “draft”, “preliminary” or other similar submittals prior to official packages in order to assist in delivery of the work. Such unofficial submittals shall not be entered into submittal logs and shall not require official response from Architect. Unofficial submittals shall not be submitted as an RFI and will be returned without action if done so. Transmit as attachment to an email.
- D. Organization of Packages:
 - 1. Complete scope of curtain wall shall be submitted in not more than 2 packages for the full scope of curtain wall work. Descriptions of portions of work for packages are preliminary, ensure that full scope is included.
 - a. Curtain wall for pre-construction mockup.
 - b. Curtain wall for remainder of work.
 - 2. Shop drawings for each package shall be complete and stand alone for the scope of work in that package. Reference to details in other packages shall not be allowed.
- E. Submittal for the mockup package shall include the following. A mock-up submittal packages that do not include the full list below shall be rejected without action.
 - 1. Product data
 - 2. NFRC CMA Certificate or alternate energy code compliance documentation.
 - 3. Shop drawings for scope of mockup
 - 4. Delegated design submittal for scope of mockup.
 - 5. Qualification data
 - 6. Energy performance certificates
 - 7. Product test reports
 - 8. Sustainability submittals
 - 9. CFMF coordination letter
 - 10. Manufacturers certificates
 - 11. Fabricator certificates
 - 12. Glass and Glazing certificates
 - 13. Installation instructions
 - 14. Sample Warranties
- F. Submittals for the final package shall include the following. Submittal packages that do not include the full list below shall be rejected without action.

1. Product data but only for new products used in the new package.
 2. Shop drawings
 3. Delegated design submittal for scope of package.
- G. Changes to any previous submittal discovered through preparation of submittals for subsequent packages shall require a revision to the original submittal materials.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product and material used.
- B. NFRC Certificate: Submit copy of NFRC label or certificate indicating products are tested, certified and labeled by NFRC under Component Modeling Approach or other independent certification compliant with energy code. Thermal modeling alone will not be acceptable.
- C. Shop Drawings: Show fabrication and installation details, materials, dimensions, gauges, trim, fasteners, closures and finishing including all attachments and joint sealants to surrounding construction. Show how system complies with specified criteria including, but not limited to accommodation of structural movement, pressure equalization, thermal cycling and control of water penetration, air infiltration and vapor migration.
1. Elevations and Plans: Minimum 1/4 inch equals 1 foot scale elevation of each area of curtainwall.
 2. Typical Curtain Wall Type Drawings: Minimum 1 inch equals 1 foot scale elevation, plan, reflected ceiling plan and wall section of each typical curtain wall type. Extent shall include one story high by one structural bay wide plus space to next vertical and horizontal mullions. Arrange on single drawing (if possible) with elevation in upper right, plan and reflected ceiling plan below and section to the right.
 3. Details: Full size details of each assembly including heads, sills, mullions, corners, floor lines, intersection with abutting construction and joints in system.
 - a. Include details of each different condition within the curtain wall system and where the curtain wall system abuts adjacent construction.
 - b. Include details cut through the end of tubular sections showing for example, closure, sealant backup, continuity of seals and anchorage at locations including but not limited to the intersection of vertical mullions with floor or threshold at doors; and at Tee or Ell intersections.
 - c. Include details cut through the ends and joints of brake metal or similar sheet fabrications showing returns, attached angles or other methods for support of sealant or connection to adjacent construction.
 - d. Show where tongues have to be milled off mullions to accept perimeter transition membrane.

4. Assembly Details: Multiple, exploded, isometric, three-dimensional details showing the sequential assembly of typical intersections including but not limited to corners, tee intersections and cross intersections. Show each sealant, gasket and accessory required for the system to function in compliance with indicated requirements.
5. Installation tolerances: Show information for the allowable tolerances within the system that still provide for proper performance.
6. Show sufficient information to trace continuity of inner and outer line of sealant and silicone membrane transition flashing to trace line of thermal control, air/moisture barrier and vapor control.
7. Where showing adjacent work such as metal panels, masonry cladding, other glazed aluminum framed systems, waterproofing, roofing, or other work adjacent to curtain wall indicate the actual shop drawing profiles of that work.
8. Show joint locations in all linear elements not provided in lengths matching unitized dimensions including but not limited to the base flashings, copings, interior stool.
9. Show firestopping specified elsewhere.
10. Shop drawings shall identify every internal gasket and sealant required for indicated performance. Gaskets and sealants cannot be noted as "by others".
11. Shop drawings shall identify every anchor, bolt, screw, clip, fastener or similar device for fixing the curtain wall in place. These cannot be noted as "By others".
12. Show every element that is part of electrical, mechanical, plumbing, fire protection, security system, alarm system, or other system that is mounted on or passes through curtain wall.
13. Shop Drawings shall be signed and sealed by the qualified professional engineer responsible for their preparation. "In-Progress" submittals shall be accompanied with a letter from the professional engineer indicating that they have actively been involved in the design of the work included in the submittal and are prepared to sign and seal the Shop Drawings if approved by the Architect.
14. Extent of Shop Drawings shall be sufficient to demonstrate compliance with indicated criteria.
15. Shop Drawings shall be prepared directly by the manufacturer with manufacturer's logo and bearing the name and contact information and signature of manufacturer's design engineer.
 - a. Shop drawings may be prepared by licensed or otherwise approved installers or fabricators, and shall be accompanied by a certification letter on manufacturers letterhead, signed by manufacturers design engineer, stating that the manufacturers engineering department has reviewed the shop drawings and Contract Documents and verifies that systems represented in the shop drawings are compliant with manufacturers recommendations, contain sufficient detail to direct construction in compliance with manufacturers recommendations, are suitable for intended application and that the shop drawings are of a level of quality and completeness as if the manufacturer prepared the shop drawings themselves.

16. Shop drawings shall be updated after successful completion of the Pre-Construction Mockup testing incorporating every adjustment, repair, addition or other change made to the PMU during the testing protocol. Identify changes.

D. Fabrication Samples:

1. Provide Fabrication Samples of the following: Include glass and accessories.
 - a. Vertical-to-horizontal intersection of typical assemblies, made from 24-inch lengths of full-size components. Include typical anchor.
 - b. Deliver fabrication samples to project site for review and approval.
2. Fabrication Samples shall illustrate the following:
 - a. Compliance with requirements of specifications.
 - b. Joinery, including concealed welds.
 - c. Anchorage.
 - d. Expansion provisions.
 - e. Glazing.
 - f. Flashing and drainage.

1.6 DELEGATED DESIGN SUBMITTALS

- A. Delegated-Design Submittal: For glazed aluminum curtain walls indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Calculation sheets shall be cross-referenced to the exact shop drawing page number and detail for the assembly being analyzed.
 2. Structural Silicone Curtain Wall: Include analysis of structural silicone glazing and structural silicone IGU edge spacers.
 3. Anchors: Include analysis of the anchors which attach the systems to adjacent construction or structure. Analyze and identify every anchor, bolt, screw, clip, fastener or similar device for fixing the curtain wall in place. These cannot be indicated as "By others".
 - a. Delegated Design Engineer shall indicate selection of proprietary anchors including but not limited to embedded slot anchors, cast-in anchors, chemical anchors, undercut anchors, and wedge anchors based on manufacturers test data and requirements for loading.
 4. Include analysis of portions of curtain wall 42" or less above finished floor for requirements for guards.
 5. Include thermal analysis of movement to be accommodated.
 6. Include structural analysis of backpans and reinforcing.
 7. Include structural analysis of metal panels and reinforcing.

8. Delegated Design Engineer or manufacturers systems engineer shall certify that the curtain wall system complies with the performance requirements for a pressure-equalized rain screen system.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For the following, demonstrating qualifications specified in this Section and in Division 01 Section 01 40 00 "Quality Requirements" and in the form specified in Division 01 Section 01 33 00 "Submittal Procedures."
 1. Manufacturer
 2. Fabricator.
 3. Installer
 4. Delegated Design Engineer
- B. Energy Performance Certificates: Submit copies of labels with NFRC-certified energy performance values from manufacturer.
- C. Product test reports. Provide reports in addition to the PMU test report for any aspect of performance not included in the PMU.
 1. Test reports shall be complete with shop drawing of the tested assembly.
 2. Test reports must be for a system substantially identical to the system proposed for this project including accessories.
- D. Manufacturer Certificates: Signed by manufacturer certifying that curtain wall and window wall system complies with the following.
 1. Compliance with requirements of Division 01 Sections 01 83 16 "Exterior Enclosure General Requirements".
 2. Compliance with performance requirements.
 3. Certify that materials are appropriate for indicated use and substrates and adjacent materials are compatible.
 4. Certify Manufacturer qualifications.
 5. Certify Manufacturer's approval of Installer qualifications.
 6. Certify Delegated Design Engineers qualifications.
 7. Certify single source responsibility.
 8. Certify acceptability to manufacturer of products specified in or required by this Section that are not produced by the manufacturer who submits this Certification including but not limited to:
 - a. Internal sealants and gaskets.
 - b. Screws, bolts, anchors, clips, and similar devices.
 - c. Glass and glazing
 - d. Insulation

9. Certify that system/assembly depicted in Shop Drawings and other submittals, if installed as detailed, will result in performance substantially the same as it did in the tests on which the manufacturer bases their predictions of performance for air and water resistance, thermal performance, condensation resistance, structural capacity and other salient performance criteria in compliance with the Contract Documents. Include the primary products, all accessories, interface and anchorage to adjacent construction and all other work of this Section included in the submittals. This certification is not intended to extend manufacturers warranty to include installation.
10. For structural silicone glazed systems, certify that the substrate for adhesion of the silicone is manufactured exactly the same as in the Approved SSG test reports, and that substrate is protected during fabrication and prepared immediately prior to glazing to maintain an exact match to the tested assembly.
11. Glass and Glazing Certificates: Coordinate with certificates indicated in 088010 for Exterior Glazing. Certify that curtain wall manufacturer has studied glass manufacturers requirements and incorporated into the work.

- E. Installation Instructions: Manufacturer's installation instructions.
- F. Re-glazing Methodology: Instructions for re-glazing of structural silicone glazing and standard glazing in the field to replace broken glass.
- G. Field quality-control reports.
- H. Monthly progress redlines of as-built shop drawings.
- I. Sample warranties.

1.8 CLOSEOUT SUBMITTALS

- A. As-Built Record Shop Drawings: Record all field conditions daily. Monthly submit in progress versions of the As-Built Record Shop Drawings. One bound set of reduced (half-size) photocopies and one electronic file (pdfs) of all final approved shop drawings signed and sealed by the delegated design engineer.
- B. As-Built Record Submittals: One bound sets of all final approved submittals and one electronic file (pdf). Organize clearly with tabs for each section.
- C. Operation and Maintenance Manual: One bound copy and one electronic file (pdf) of a maintenance manual describing the various materials, equipment and procedures for cleaning and maintaining the work of this Section. Include the manufacturer's data for all components of each glazing system and type, with supplier/source and contact information. Provide replacement procedures, replacement components and methods of replacement of damaged components of glazed steel and aluminum exterior wall systems to ensure full service capability of the work.
- D. Final executed system guarantees and warranties.

1.9 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer capable of fabricating glazed aluminum curtain walls that meet or exceed performance requirements indicated and of documenting this performance by certification, labeling, and inclusion in lists.
1. Experience: Minimum five (5) years producing products similar to those required for this Project. Provided products for three (3) projects of scope, schedule and complexity similar to this Project within last two (2) years as acceptable to Architect.
 - a. Certify compliance. Include project descriptions with Owner and Design Professional contacts for previous experience and resume for designer.
 2. Single Source Requirements: Products shall be supplied by one (1) manufacturer. Accessory products including, for example, fasteners, sealants and anchors may be from other than primary manufacturer if approved in writing by primary manufacturer and Architect.
- B. Delegated Design Engineer: Professional Engineer, licensed in State of Delaware and having a minimum of five (5) years documented experience designing systems similar to those required for this Project. Delegated Design Engineer shall sign and seal calculations and shop drawings.
1. Delegated Design Engineer shall sign and seal calculations and shop drawings.
 2. Delegated Design Engineer's scope shall include everything indicated for delegated design submittals unless provided by manufacturers engineers. Provide multiple engineers with appropriate expertise to provide full scope of submittals if necessary.
 3. Delegated Design Engineer shall select proprietary anchors including but not limited to embedded slot anchors, cast-in anchors, chemical anchors, undercut anchors, and wedge anchors based on manufacturers test data and requirements for loading.
 4. Certify compliance. Include project descriptions with Owner and Design Professional contacts for previous experience and resume for designer.
- C. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of curtain wall systems required for this Project.
1. Experience: Minimum five (5) years fabricating and installing products similar to those required for this Project.
 2. Completed three (3) projects of scope, schedule and complexity similar to this Project using systems similar to those required for this Project within last two (2) years as acceptable to Architect.
 3. Adequately trained by manufacturer and recommended in writing by manufacturer for type of fabrication and installation required for this Project.
 4. Certify compliance. Include project descriptions with Owner and Design Professional contacts for previous experience.

- D. Referenced Requirements: Comply with requirements of the following except as modified by the Contract Documents or code. Where a suggestion or recommendation is included in the reference material, comply as if written herein as mandatory. In the event of conflict between the referenced standards and the requirements of the Contract Documents, the more stringent shall govern.
1. American Architectural Manufacturers Association (AAMA) documents:
 - a. CW 13: Structural Sealant Glazing Systems (A Design Guide).
 - b. AAMA 850 Fenestration Sealants Guide Manual
 - c. AAMA GAG-1 Glass and Glazing
 - d. AAMA TIR-A9 Metal Curtain Wall Fasteners
 - e. AAMA TIR-A11 Maximum Allowable Deflection of Framing Systems for Building Cladding Components at Design Wind Loads
 - f. AAMA TIR-A1, Sound Control for Fenestration Products
 - g. "Voluntary Guide Specifications for Structural Glazing
 2. "Aluminum Design Manual" and "Aluminum Standards and Data" issued by the Aluminum Association (AA).
 3. Code for Welding in Building Construction" issued by the American Welding Society (AWS), including but not limited to:
 - a. AWS D1.1 Structural Welding Code – Steel.
 - b. AWS D1.2 Structural Welding Code – Aluminum.
 - c. AWS D1.3 Structural Welding Code – Sheet Steel
 - d. AWS D1.4 Structural Welding Code – Stainless Steel
 4. American National Standards Institute (ANSI),
 - a. ANSI Z97.1 American National Standard For Safety Glazing Materials Used in Buildings - Safety
 5. Glass Association of North America Glazing Manual (GANA):
 - a. "Glazing Manual"
 6. Sealant and Waterproofing Institute (SWRI): "Sealant, Waterproofing and Restoration Institute: Sealants: The Professional's Guide".
 7. Insulating Glass Manufacturer's Alliance (IGMA): IGMA TM-3000 North American Glazing Guidelines for Sealed Insulating Glass for Commercial and Residential Use.
 8. National Association of Architectural Metal Manufacturers (NAAMM): "Metal Finishes Manual for Architectural and Metal Products"
 9. The specified standards issued by the Structural Steel Painting Council (SSPC).
 10. The specified documents of the Consumer Products Safety Commission (CPSC).
 11. Guidelines of the Glass Architectural Spray Coaters Association (ASCA).
 12. The "Architectural Sheet Metal Manual" published by the Sheet Metal and Air Conditioning Contractor's National Association (SMACNA).

13. The hardware finish designations of the Building Hardware Manufacturers Association (BHMA).
 14. National Fenestration Registration Council (NFRC):
 - a. NFRC 100 Procedure for Determining Fenestration Product U-Factors.
 - b. NFRC Simulation Manual.
 15. CPSC 16 CFR, Part 1201-03, Safety Standards for Architectural Glazing,
- E. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.
- F. Structural-Sealant Glazing: Comply with ASTM C 1401 and quality control program required by structural sealant manufacturer.
- G. Curtain Wall Quality Control Program: Establish and administer a quality control program to ensure compliance with requirements. Glazing Quality Control Program shall be incorporated into Quality Control Program specified in Division 1 Section 01 83 16 "Exterior Enclosure General Requirements":
1. Document each aspect of quality control plan, including statistical data regarding compliance to tolerances and indicated requirements.
 2. Incorporate any quality control measures required by manufacturers of primary glass, structural silicones, or other primary products and materials.
 3. Inspectors and other officials of the Quality Control Program may be employees of curtain wall manufacturer but shall be substantially independent of manufacturing, fabricating and installing department and staff. Inspectors do not need to be from an independent company.
 4. Plan shall include names of approved inspectors who shall initial each quality control inspection or check. Include qualifications of inspectors.
 5. Determine frequency of each type of inspection and checking, unless otherwise indicated. Document measurements, counts, and other quantitative checking. Frequency shall be adequate to provide statistically significant sampling.
 6. Provide adequate tools, measuring devices and equipment at plants and on site required to verify compliance. Maintain at the Project site a device for checking the orientation of Low-E or other clear or hard to detect coatings.
 7. Inspect, test and check at each phase of Work for compliance with requirements including, but not limited to, the following:
 - a. Checking of raw materials upon delivery to fabrication plant.

- b. Checking as materials are cut to size, edge-polished or prepared, cleaned, edge-deleted, formed and otherwise prepared for fabrication.
 - c. Checking that coatings are properly oriented, especially clear Low-E coating or similar coating hard to detect.
 - d. Checking of each step of fabrication of insulating glazing units, including checking of edge-deletion, adhesion, color consistency of primary and secondary seals, gas filling, orientation of Low-E or other clear or hard to detect coatings, and as otherwise required to comply with requirements.
 - e. Checking of each step of structural silicone glazing including but not limited to inspection and testing of substrate, edge deletion, cleaning and surface preparation, installation of spacers, proper mixing of multi-component sealants, installation and tooling of structural silicone, bedding of glass into silicone, temporary supports, proper curing, clean up, bond strength to glass and metal substrates, and as otherwise required to comply with requirements.
 - f. Checking that patterns are properly aligned from unit to unit.
 - g. Checking that certified IGU are properly marked or labeled.
 - h. Checking that roll wave distortion is properly oriented.
 - i. Checking of fabricated glass prior to crating and shipping.
 - j. Checking of fabricated glass and glazing accessories upon delivery to glazing factory or site and approval before installation.
 - k. Checking of frames to receive glazing for dimensional tolerances.
 - l. Checking substrates for preparation, cleaning and priming.
 - m. Checking of glazing procedures.
 - n. Checking of proper orientation of Low-E or other clear or hard to detect coatings
 - o. Checking of substrates and structure to which curtain wall is attached or anchored.
 - p. Checking of each phase of installation.
 - q. Checking of dimensions and tolerances of fabricated units.
 - r. Checking of count of each type of fabricated unit.
 - s. Checking for tolerances for installed work.
 - t. Checking of proper installation.
 - u. Checking of force required for operable sash.
 - v. Checking of installed work for protection and soiling.
8. Document and record each step of process. Retain documents for minimum 10 years.

1.10 PRECONSTRUCTION PERFORMANCE AND AESTHETIC MOCKUPS (PMU)

- A. Mockups: Provide curtain wall elements for mockups specified in Section 01 43 25 "Exterior Enclosure Performance Mockup" to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockup of typical wall area as shown on Drawings.
2. Testing shall be performed on mockups according to requirements in Section 01 43 25 "Exterior Enclosure Performance Mockup".
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless contractor specifically identifies deviations and Architect specifically approves such deviations in writing.

1.11 DELIVERY, HANDLING AND STORAGE

- A. Protect prefinished surfaces with wrapping or strippable coating. Do not use adhesives which bond or leave a residue.
- B. Ship and store under conditions which will not have a deleterious effect on the finished work.'
- C. Protect during shipping and storing to eliminate water entering through weeps and from standing inside panel. Shipping panels flat is not allowed.
- D. Attach sticker, tag or other identification to each panel as identified on shop drawings.

1.12 WARRANTY

- A. Special Assembly Warranty: Contractor agrees to furnish labor and material to repair or replace components of glazed aluminum curtain wall that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Noise or vibration created by wind and/or thermal and structural movements (rain or hail impact noise is excluded).
 - c. Failure of system to meet performance requirements.
 - d. Failure of operating components to function normally.
 - e. Loosening or weakening of fasteners, attachments, hardware and other components.
 - f. Water leakage or air infiltration within specified performance requirements.
 - g. Deterioration, fading, excessive non-uniformity, pitting, cracking, peeling, crazing or discoloration of finishes and other materials beyond normal weathering.
 - h. Loss of effective glass bite due to shifting of glass or loss of effective glass bearing of setting blocks due to shifting of glass and/or blocks.
 - i. Adhesive or cohesive sealant failures or crazing on surface of sealant.
 - j. Gaskets or weather strips hardening, discoloration or disengagement.
 - k. Collapse, slumping or loosening of support of thermal insulation or fire safing insulation.

2. Include labor, glazing accessories and any damaged framing materials necessary to remove and replace damaged or deteriorated glass and glazing covered under warranties in Section 08 00 10.
 3. Warranty Period: Five years from date of Substantial Completion.
- B. Manufacturer's Warranty on Structural Silicone Glazing: Provide written Warranty signed by manufacturer of structural silicone agreeing to replace structural silicone sealants not performing to specified criteria. Deterioration of structural silicone glazing is defined as cohesion or adhesion failure not attributed to substrate failure.
1. Warranty Period: 10 years from date of Substantial Completion.
- C. Special Finish Warranty (Exterior Surfaces): Standard form in which coating manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Warranty Period: 20 years for AAMA 2605 finish from date of Substantial Completion
- D. Special Finish Warranty (Interior Surfaces): Standard form in which coating manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period when used on the interior of the building.
1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Warranty Period: 10 years for AAMA 2603 finish from date of Substantial Completion for surfaces exposed to interior conditions only.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design unitized aluminum curtain wall system with all accessories included in this specification section.
1. Design each anchor bolt, screw or other device to attach work of this section to adjacent construction.
 2. Services shall include but not be limited to those identified for required delegated design submittals.
- B. General Performance: Comply with performance requirements specified, as determined by testing of glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
1. Comply with performance criteria indicated in Section 01 83 16 "Exterior Enclosure General Requirements" and additional criteria indicated herein.
 2. Glazed aluminum curtain walls shall withstand indicated movements of supporting structure.
 3. Failure also includes the following:
 - a. Thermal stresses transferring to building structure.
 - b. Glass breakage resulting from manufacturing, fabrication, or installation defect. Glass breakage by others is excluded.
 - 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. Performance Mockup and Preconstruction Testing: Provide a glazed aluminum curtain wall which successfully completes testing protocol specified in 014325 "Exterior Enclosure Performance Mockup" in addition to all criteria listed in this section.
- D. Structural Loads: As indicated in Section 01 83 16 and on Structural drawing S-100.
1. Guard loading: Any unitized curtain wall surface lower than 42" above adjacent floor, paving or walking surface shall be designed for both 50 plf and for or 200 lbf point load applied to each mullion at 42" above floor or less. Glazing or other infill panels shall be designed for 50 lbs applied to any 12 by 12 inch area so as to produce the maximum load effects. Comply with ASCE 7 Section 4.5.1.1. Loads shall not be applied concurrently.
 2. Impact loading: Comply with building code and CPSC Standard 16 CFR 1201.
- E. Structural Requirements at Design Load:

1. General:
 - a. Either allowable stress design (ASD) and load and resistance factor design (LRFD) are acceptable.
 - b. For allowable stress design, allowable stress shall not be increased for individual loads or load combinations.
 - c. Applicable loads shall be considered in accordance with the load combinations specified by the codes. Effects from one or more transient loads not acting shall be considered.
 - d. Design brackets and welded anchors to carry 2 times the self-weight without causing overstress or slipping of anchors.
2. Deflection of any member in a direction normal or perpendicular to plane of wall when subjected to design loads shall not:
 - a. Exceed limits in Publication No. AAMA TIR-A11, Maximum Allowable Deflection of Framing Systems for Building Cladding Components at Design Wind Loads, when member supports only glass or glass and metal spandrel panels as follows: "At design wind loads, deflections of building cladding members for spans up to 13'-6" shall be limited to $L/175$. For spans greater than 13'-6", but less than 40 feet, deflections at design wind loads shall be limited to the more conservative value of $L/240$ plus 1/4 inch.
 - b. For the face of metal panels deflection shall be value as required to eliminate visible oil canning as defined in Section 01 83 16.
 - c. Exceed the indicated deflection limits above at two times the length of a cantilevered framing member.
3. Thermally broken members: Meet specified criteria and minimum certified testing criteria and procedures as described by the AAMA TIR-A8 performance standards.
4. Deflection of any member in a direction parallel to face of glazing when subjected to design loads shall not:
 - a. Exceed $L/360$ of clear span
 - b. Exceed amount which reduces glazing bite to less than 75 percent of design dimension.
 - c. Exceed amount which reduces edge clearances between framing members and glazing below edge clearances required to accommodate movements.
 - d. Exceed $1/4$: for spans up to 16 feet or $3/8$ " for spans greater than 16 feet for corner mullions.
5. Net deflection parallel and perpendicular to enclosure surface for framing members at perimeter sealant joints shall not exceed smallest of: values specified above, 50 percent of joint width, or movement capacity of sealant.
6. Twisting (rotation) of horizontal members due to the weight of the glass should not exceed 1 degree measured between ends and center of each span.

7. Deflection of sheet metal shadow boxes and backpans: limited to $l/60$ and maximum $3/4$ inch, except less if required to noise from movement or detrimental effect on the performance of system.
8. The anticipated movement of the framing members must not exceed the movement capabilities of adjoining sealants.
9. The movement of the framing members must not cause disengagement of applied snap covers or trim.
10. The design of the framing members must accommodate differential movement in adjacent framing members such as might occur at jambs, parapets, unusual geometries and other similar conditions.
11. The framing members must be able to resist any secondary bending moments resulting from axial loads acting through eccentricities caused by large deflections, such as, P-Delta effects.
12. In order to prevent disengagement of the infill material, design of systems incorporating large infill panels must also address the center deflection of the infill panels in conjunction with the framing deflection.
13. Where various exterior enclosure systems are interconnected, design all systems for the most restrictive individual system deflection criteria or provide for adequate flexibility within the connections to allow differential deflection without adversely affecting any of the connected systems.
14. Glass Deflection:
 - a. Limit deflection of glass supported on 4 sides normal to its plane at full design load to lesser of $L/50$ of short span or 1 inch, whichever is less.
 - b. Limit deflection of cantilevered glass supported on one edge to 1" under guard rail loading without windload.
 - c. Limit deflection of cantilevered glass supported on one edge to $L/25$ under wind loading.
 - d. Limit deflection if necessary so glass does not deflect to the point of contacting adjacent construction.
 - e. Limit glass deflection to not cause stresses that could result in early failure, deterioration or cause to void warranty. Manufacturer shall certify that design does not cause undue pressure in glass as placed and designed.
 - f. Limit deflection of glass supporting members when carrying full design load so not to reduce glass bite below 75 percent of design dimension. Member shall have a $1/8$ inch minimum clearance between itself and edge of fixed panel, glass or fixed part immediately adjacent and shall not impair function of or damage any joint seals when deflected.
15. Stresses shall not exceed allowable values established by Specifications.
16. Glass and structural silicone sealant shall not be assumed to contribute to framing member strength, stiffness or lateral stability without specific analysis by delegated design engineer and inclusion of recommendations of silicone sealant manufacturer.
17. Interior finishes including gypsum wallboard shall not be assumed to contribute to framing member strength, stiffness or lateral stability.

18. Compression flanges of flexural members may be assumed to receive effective lateral bracing only from members in actual contact with compression flange and adequately anchored to building structure. Points of contraflexure shall not be regarded as lateral braces or as end points of an unbraced length; unbraced length shall be actual distance between effective lateral braces as defined above.
 19. Design exterior panel connections for 1.33 times lateral seismic force, and with sufficient ductility and rotational capacity to preclude brittle failure. Fasteners attaching connector to panel or structure, such as bolts, inserts, welds, dowels and similar fasteners, shall be designed to ensure ductile behavior of connector or shall be designed for four (4) times lateral seismic force. Fasteners embedded in concrete shall be attached to or hooked around reinforcement, or shall be otherwise terminated so as to effectively transfer seismic force to reinforcement.
 20. Limit deflection as required to not adversely affect performance for water penetration, air leakage and other similar specified criteria.
 21. Limit deflection as required to control oil canning.
- F. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:
1. Fixed Framing and Glass Areas: 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 15 lbs/sq. ft..
 2. Criteria for water infiltration testing is for no uncontrolled water as defined in Section 01 83 16.
- H. Water Penetration under Dynamic Pressure: Test according to AAMA 501.1 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested at 15 lbf/sq. ft.
 2. Criteria for water infiltration testing is for no uncontrolled water as defined in Section 01 83 16.
- I. Energy Performance: Certify and label energy system performance according to NFRC as follows:
1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than the following as determined according to NFRC 100:
 - a. At vision glass: 0.40 Btu/sq. ft. x h x deg F.
 - b. At spandrel or shadow box: 0.20 Btu/sq. ft. x h x deg F
 2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.25 as determined according to NFRC 200.
 3. Values shall be determined for project specific glazing sizes.

- J. Condensation Resistance: Minimum CRF of 60.
- K. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
 - 2. Provide for all thermal movement in the plane of the exterior wall system without causing buckling, stress on glass, metal, or joint seals, undue stress on structural elements or glass, excess loads on fasteners, reduction of performance or other detrimental effects.
 - 3. Full movement allowances including assembly and installation tolerances shall be incorporated into all junction/components at each expansion joint or assembly.
- L. Movement of the Structure: Design framing system and connections to maintain clearances at openings, to allow for fabrication and construction tolerances, to accommodate live-load deflection, shrinkage and creep of primary building structure, and other building movements.
 - 1. Accommodate the following vertical movement of the structural frame:
 - a. Deflection of edge of slab, spandrel beams or other structural members supporting curtain wall: Differential vertical movement and long-term deflection after exterior façade installation plus thermal movement of curtain wall: Minimum 3/4"
 - 2. Accommodate the following lateral movement (drift) of the structural frame when tested per AAMA 501.4 at the following design displacement.
 - a. Resulting from wind loading: $H/400$ (H is the floor to floor height)
 - b. Resulting from seismic event: $0.015H$
 - 3. Provide moveable joints to accommodate the full range of movement requirements including manufacturing tolerances, construction tolerances, thermal movement, lateral movement, floor sag, beam sag, live load deflection and column settlement.
 - 4. Allowance for movement shall be in addition to allowance for building construction tolerances.
 - 5. Joints shall accommodate the worst possible combination of erection tolerances and anticipated movements to prevent loads of any kind being transferred from the building into the glazing systems, excessive movements of any joints or failure of weather seals.
 - 6. Design movement joint and select sealant products to accommodate all required expansion and contraction within joint tolerances indicated on the approved shop drawings and within the sealant movement limits recommended by the sealant manufacturer under loaded and unloaded conditions.
 - 7. All movement allowances shall be consistent and applied across all junctions and/or components for each expansion joint system or assembly.

8. For design, elastic deflections due to earthquake loads shall be multiplied by the deflection amplification factor (Cd).
 9. Shore, pre-load, or utilize other methods to limit or control building movements during installation.
- M. Movement within areas of SSG: Accommodate both thermal movement and movement of structure without imparting stress on SSG joints.
1. Areas of curtain wall with SSG verticals shall be designed with a single point of deadload anchorage and shall accommodate vertical thermal movement at all other points of anchorage.
- N. Loading on IGU: Limit edge pressure transmitted from framing system to the edges of IGU to a maximum of 10 pounds per linear inch.
- O. Structural-Sealant Joints: As specified in Section 08 80 10 "Exterior Glazing"

2.2 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the following. Adapt and modify systems as necessary to comply with indicated requirements.
1. Oldcastle Building Envelope Reliance
 2. Wausau SuperWall
 3. YKK AP YCW 750

2.3 SYSTEM DESCRIPTIONS

- A. Curtain Wall Systems:
1. Glazing Method: Pressure plate outside glazing 4 sides typical with Structural silicone glazing at mullions where indicated.
 2. Framing Description: 2 1/2" wide. Depth approximately 6 1/2" from outside face of glass to interior face of mullion typical.
- B. Framing Members: Extruded aluminum framing members of thickness required and reinforced as required to support imposed loads.
1. Construction: Thermally broken to comply with indicated thermal performance.
 2. Thermal Break Construction: Continuous extruded polyamide nylon with glass fiber reinforcing, mechanically crimped into cross-knurled cavities.
 3. Reinforcement: Reinforce the mullions internally with steel or aluminum as required to comply with performance criteria.
- C. Two (2) Stage Pressure-equalized Rainscreen Weatherproofing: System shall provide redundant weatherproofing (both internal to system and at interface of system with

adjacent construction) to control infiltration of water and air which may bypass outer rainscreen and to maintain continuity of inner air barrier/vapor retarder by means of pressure-equalized cavities as defined in Section 01 83 16.

1. Every glazing panel shall be a self-contained air cavity.
 2. Joints between unitized panels shall have exterior rainscreen gaskets, with an air and watertight line of control approximately in line with the inner surface of glass and with an additional airseal at the inner line of mullion intersections.
 3. Rainscreen layer shall be detailed to provide water-tight performance by resisting water penetration forces including gravity, kinetic energy (wind driven rain), capillarity, surface tension, and pressure differential.
 4. Only incidental water maybe allowed to penetrate outer glazing seal or rainscreen gaskets.
 5. Any incidental water penetrating outer glazing or rainscreen shall be weeped harmlessly to exterior.
- D. Perimeter Interface: Where abutting adjacent construction, the system shall be capable to:
1. Accept silicone membrane transition flashing at the back of the glazing pocket to provide continuity of air barrier and water resistant barrier.
 2. Accept an outer line of rainscreen sealant between outer face of perimeter mullions and adjacent wall cladding.
 3. Glaze in metal flashing in line with outside face of glass over a pocket filler as indicated.
 4. Sealing of outer rainscreen shall be independent of glazing.
 5. Compartmentalize air cavity at adjacent construction as indicated for pressure-equalization.
- E. All components of system that have faces exposed to both interior and exterior shall be thermally broken as required for indicated performance criteria.
- F. Systems which require blind seals, seals that cannot be tooled in their final location, seals with 3 sided adhesion at movement joints, seals not adequate to accommodate required movement or other seals which do not comply with SWRI recommendations and which are required to maintain the performance of the air barrier, even if such conditions have adequately passed laboratory testing, will not be allowed.
- G. Do not allow water to puddle or stand. Surfaces shall be pitched towards drains or weeps. Provide upstand legs at upper limit to control water penetration.
- H. Bottom edge of projecting elements shall have a minimum 1/4" by 1/4" recessed drip within 1" of the outer edge.
- I. Air Barrier/Vapor Retarder: System shall be air tight, vapor tight and water tight at interior face of glazing and interior face of glazing pocket.

1. Backpans shall provide continuous air barrier/vapor retarder sealed to the glazing pocket. Provide continuity of air barrier/vapor retarder across lines of air and vapor control.
 2. Where vapor retarder is at a location other than the inside face of glass such as at spandrel areas, detail system to maintain continuity of air barrier/vapor retarder across framing members, system and connection to adjacent air barrier/vapor retarder materials.
- J. All gaskets/weather stripping/spacers shall have continuous mechanical engagement to framing members; adhesive attachment is not acceptable.
- K. Provide filler panels along lengths of open extrusions to allow for back-up of full depth of sealant and backer rod where sealant is indicated or required to meet specified criteria. Seal such filler panels if required for performance.
- L. In the ends of mullions and similar extrusions, fill cavity with compressible silicone blocks, metal plate or other device and seal air tight if required for continuity of other seals at corners and where vertical mullions intersect horizontals.
- M. Brackets and Reinforcements: High-strength aluminum with non-staining, nonferrous shims for aligning system components.
- N. Materials:
1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - a. Sheet and Plate: ASTM B 209.
 - b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
 - c. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
 - d. Structural Profiles: ASTM B 308/B 308M.
 2. Steel Reinforcement: Coat with 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.
 - a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
 - b. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
 - c. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.
 3. Stainless Steel:
 - a. For shapes, plates, bars and strip (exposed): AISI Type 316, ASTM A 666.
 - b. For shapes, plates, bars and strip (concealed): AISI Type 304, ASTM A 666.
 - c. Fasteners: AISI Type 303, 304 or 316 non-magnetic.

- 1) Bolts and screws: ASTM F 593.
 - 2) Nuts: ASTM F 594.
 - 3) Button and countersunk head screws: ASTM F 879.
4. Aluminum Composite Material: Not allowed.

2.4 ACCESSORIES

- A. Insulation: Semi-rigid, rock or slag mineral fiber, complying with ASTM C 612, un-faced except where indicated to be foil-faced, including manufacturer's written recommended anchors, stick pins, foil-tape, sealants and accessories.
- B. Pocket Fillers: Where spacers are needed to fill glazing pockets use industrial grade phenolic material or other material that does not react to water and provides thermal break.
1. Solid Phenolic: Abet Laminati Stratificato or Franklin Fibre or equivalent.
 2. Wood is not allowed.
 3. Aluminum without thermal break is not allowed.
- C. Tapered Blocks or other fillers: Use industrial grade phenolic indicated above.
- D. Fasteners and Accessories: Corrosion-resistant, non-staining, 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. If exposed use fasteners with countersunk Phillips screw heads, finished to match framing system.
 4. Materials:
 - a. Contacting Aluminum and Dissimilar Metals: Stainless steel, ASTM F 593 and F 594, Alloy Group 1.
 - b. Contacting Steel or Galvanized Steel Only: Hot dip galvanized steel conforming with ASTM B 633, SC 4 or ASTM A 153.
 - c. Exposed to the weather or in internal cavities subject to wetting: Stainless steel, ASTM F 593 and F 594, Alloy Group 1.
- E. Silicone Membrane Edge Transition Flashing Sheet: Pre-extruded silicone sealant membrane by Dow, GE, Pecora or Tremco.
1. Sheet shall be translucent to allow visual inspection of underlying adhesive sealant.
 2. Primers, liquid-sealant, cleaning agents and accessories as recommended in writing by manufacturer.

- F. Spray Foam Insulating Sealant: Minimal expanding, polyurethane foam, classified as a sealant per UL R13655. Closed cell content minimum 80% per ASTM D 2856, Flame spread less than 25, smoke development less than 450 per ASTM E 84.
1. Basis of Design: Dow Great Stuff Pro Window and Door or equivalent.
- G. Filters: Silicone compatible PVC-coated reticulated open cell polyurethane foam, 30 to 40 pores per 1 linear inch sized for installation at 30-50 percent compression.
1. Provide PVC Coated SIF-G Industrial Foam by Stephenson and Lawyer, Inc or equivalent.
- H. Slip Joint Linings/Sleeves: Provide extruded aluminum profile sleeve spacers and/or suitable bearing pads, as required, to ensure free movement between surfaces where expansion and deflection movements are intended. Provide Teflon, Delrin or similar high impact dimensionally stable, moisture resistant shims or pads or equivalent plastic units recommended by the manufacturer to permanently prevent "freeze up" of joints. All sleeves, spacers, bracing pads and shims must be approved for interior use per building code.
- I. Coatings:
1. Shop Primer for Steel: Zinc dust rich primer SSPC Paint 20 or Paint 29 Organic zinc-rich epoxy coating.
 2. Touch-up Primer for Galvanized Steel: Primer with minimum 80 percent zinc in dry film complying with SSPS 20.
 3. Dissimilar Metal Coating: Cold-applied asphalt mastic complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat or other non-conductive, non-absorptive material.
 4. Sound Dampening Compound: Visco-elastic sound dampening material with a flame spread rating of less than 25 and a smoke developed rating of less than 50 when tested in accordance with ASTM E84. Provide one of the following or equivalent:
 - a. Antivibe DL-10 by Bachford Ltd
 - b. GP-1 Damping Compound by Sound Coat
 - c. Vibrasorb Damping Compound by E. N. Murray Co., Inc.
- J. Foam Tape: 9 pcf density (self-adhesive) foam tape with flame retardants to meet FMVSS 302 flammability standard. Norton V 780 or approved substitution. Provide tape 1 inch wide, unless otherwise indicated by the following thickness.
1. Provide 1/8 inch thick at metal panels, concrete or other smooth substrate.
 2. Provide 1/4 inch thick at masonry or similar rough substrate.
- K. Butyl Coated Foam Tape: Soft, compressible PVC foam core encapsulated with 100 percent solids butyl. "Norex" by Norton or approved substitution. Provide 1/8 inch by 1/2 inch tape, unless otherwise indicated.

- L. Double Stick Tape: Closed-cell foam tape for structural bonding, 3M "VHB" Tapes or approved equivalent. Minimum peel adhesion of 15 pounds per inch. Use minimum thickness tape to provide hairline joints where exposed.
 - 1. Primers, cleaning agents and accessories as recommended in writing by tape manufacturer.
- M. Concealed Flashing: Aluminum or dead-soft, 0.018-inch- thick stainless steel, ASTM A 240/A 240M of type recommended by manufacturer.
 - 1. Primers, cleaning agents and accessories as recommended in writing by silicone manufacturer.

2.5 ANCHORS and BRACKETS

- A. Provide all required anchors and brackets sufficient to properly support the curtain wall off the structural steel frame and structural concrete work that has been sized and designed on the structural drawings. Members not designed and sized on the structural drawings shall be provided as the work of this section.
- B. Fabricate from aluminum or structural steel or a combination to properly anchor the curtain wall to the building structure or foundation or to cold-formed metal framing. Provide brackets of sufficient size and structural capacity to bridge between curtain wall system and the structural members or foundations indicated on the structural drawings.
 - 1. Design anchors to be adjustable with shims, elongated holes, or other similar method to provide plus or minus 1" of adjustment in three directions. After erection anchor shall be designed for permanent welding or locking into final location so that slip-critical connections are not necessary.
 - 2. Anchors shall be designed to not require movement at point of attachment to mullions or where sealed to shadow box backpan.
 - 3. Size to transmit loads back to edge of slab or building structure.
 - 4. Allow for building and system movement.
 - 5. Accommodate fabrication and installation tolerances.
 - 6. Transmit load to foundation, slab edge, CFMF or structural steel in a fashion that does not exceed the capacity of the supporting element.
 - 7. Only aluminum or stainless steel allowed in areas exposed to weather or exposed inside cavities subject to wetting.
- C. Anchors in Concrete: Design anchors for edge clearance at concrete as required for the loading and per manufacturers recommendations.
- D. Exposed Anchors: Comply with requirements above but provide special bent plate channel.

1. Channel shall be mounted over a spacer, fixed with an erection bolt and welded into fillet. Provide epoxy putty over fillet and grind smooth and square.
 2. Bolts at Exposed CW Anchors: Custom, 316 Stainless steel, round, smooth low-profile head, socket drive bolts with internally thread barrel post with matching head, sized as required by load, minimum 3/4" barrel diameter, by Accurate Manufactured Products Group or equivalent.
- E. Embedded Slotted-Channel Inserts: Steel channels with anchor straps or studs selected by Delegated Design Engineer for anchoring conditions, layout, loading, and substrate. Hot dip galvanize per ASTM A 123 after fabrication. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B633, Class Fe/Zn 5, as needed for fastening to inserts.
- F. Brackets: Provide brackets fabricated from structural steel to bridge between the structural steel or concrete structural frame shown on the structural drawings and anchors as required to properly support the curtain wall.
1. Do not assume miscellaneous steel is provided by others.
 2. Brackets shall be designed to not impart excessive loads onto structure. Provide stiffeners and reinforcement of primary structure if necessary to support loads.

2.6 INTERIOR TRIM AND ACCESSORIES

- A. Interior brake metal shall be aluminum, minimum wall thickness 0.125 inch", profiles as indicated on Drawings. Thickness, reinforcement, and anchorage as required for indicated performance criteria
1. Aluminum Composite Material: Not allowed.
- B. Where interior trim intersects with curtain wall or with other trim provide:
1. At ends of extruded trim, cut square, de-burr and prepare for a hairline joint.
 2. At ends of brake metal trim, hem the edge and prepare for a hairline joint.
- C. Interior trim shall be extruded aluminum minimum wall thickness 0.080, finish to match adjacent mullions.
1. Where size indicated for trim is beyond the size of an extrusion that can fit within a 9 inch diameter circle, provide fabricated aluminum plate minimum thickness 0.080. Plate shall typically be back-welded to extrusion to form crisp corners
 2. Furnish, for example, two-piece extension clip with snap-on cover, corner fillers, finished panels at shadow box, mullion covers (not acoustic rated), head trim, sill, stools, and partition closers as indicated. Individual pieces shall be fabricated to snap together forming hairline joints.

- D. Interior Stool and Trim: Extruded aluminum, minimum, designed to be cantilevered off the interior face of curtain wall mullions along bottom of curtain wall to close gap and allow movement.
1. Fabricate Stool from 0.125" aluminum brake metal.
 2. Joints in interior stool shall align with centers of mullions.
 3. Provide a back-up splice plate/alignment lug at each joint. Mill out portions of the extrusion to allow for back up plate at all exposed surfaces.
- E. False Mullions: Extruded aluminum members matching the profile of adjacent mullions located behind continuous IGU.

2.7 EXTERIOR TRIM AND ACCESSORIES

- A. Mullion Covers: Snap on mullion-covers in profiles indicated and to coordinate with adjacent aluminum panels.
1. Extended Mullion: Provide deep extension trim to profiles indicated.
- B. Brake metal and other similar formed exterior trim shall be extruded aluminum, minimum wall thickness 0.125 inch" except provide 20 gage stainless steel where indicated on drawings, profiles as indicated on Drawings. Thickness, reinforcement and anchorage as required for indicated performance criteria.
1. Aluminum Composite Material: Not allowed.
- C. Insulated Metal Panel: Panels made of non-combustible mineral board core and aluminum facer sheets matching thickness of glazing and designed for installation into glazing pocket. Exposed facer sheets shall match the adjacent aluminum curtain wall. Concealed surfaces may be mill finish aluminum.
1. Where panels are indicated with perimeter sealant provide folded return on face sheet minimum 3/4" deep and seal all corners.
- D. Brake metal counterflashing at base of CW: Provide two-piece stainless steel flashing that mounts into the glazing pocket and covers over base flashing and insulation.
1. Comply with requirements of section 076000.
 2. Provide a backup plate at each joint.
- E. False Mullions: Extruded aluminum members matching the profile of adjacent mullion covers located outside of continuous IGU.

2.8 SEALANTS (NON-STRUCTURAL)

- A. All joints sealed as part of the fabrication or erection procedure, shall be sealed with an approved silicone sealant in color selected from manufacturers standard charts to match the adjoining surfaces or as may be required by the Architect. All perimeter sealant (to adjacent construction) shall be silicone sealant specified in Section 07 92 05.
- B. Silicone selection to be based on manufacturers recommendations and preconstruction adhesion test.
- C. Silicone sealant shall be as manufactured by Dow Corning, Pecora, Tremco or General Electric (Momentive).
- D. Glass PIB and secondary seals shall be black.
- E. Internal seals not exposed to view will be silicone as determined by the curtain wall fabricator.
- F. In using specified sealants, strictly observe the printed instructions of sealant manufacturer regarding joint size, limitations, backer rod, mixing, cleaning, surface preparation, priming and application.
 - 1. A primer shall be used if recommended by the sealant manufacturer.
 - 2. Sealant shall not be applied when substrates are wet or when the temperature is below limits recommended by sealant manufacturer.
- G. Do not allow "Three Surface Adhesion" at joints subject to movement, provide bond breakers or backers. Three surface adhesion is acceptable in static joints.
- H. Compatibility: ASTM C1087, Submit an overall compatibility schedule for all sealants with all contact surfaces, in spreadsheet format, with written verification attached from sealant manufacturer for same. Demonstrate that all substrates are compatible with the sealant after 21 days exposure to ultra violet, 2000 - 4000 (micro watt u.v. radiation).
- I. Staining: Include ASTM C1248 stain response testing for sealant and primers in direct contact with natural stone, concrete, or wood. All structural silicone to be black.
- J. All non-structural silicone to be black.

2.9 SEALANTS (STRUCTURAL)

- A. All components which are adhered with a structural silicone sealant/adhesive as part of the fabrication, glazing or erection procedure, shall be sealed/adhered with an approved 2-component structural silicone, as manufactured by General Electric (Momentive), Dow Corning, or Tremco and approved by the Architect.

- B. All glazing with structural silicone sealant/adhesive shall be accomplished in a shop.
- C. In using specified sealants, strictly observe the printed instructions of sealant manufacturer regarding joint size limitations, backer rod, mixing, cleaning, surface preparation, priming and application.
- D. A primer shall be used, unless printed instructions advise to the contrary.
- E. Sealant shall not be applied when substrates are wet or when the temperature is below 40 deg. F.
- F. Units shall not be moved until structural silicone seal has achieved full cure.
- G. Do not allow "Three Surface Adhesion" at joints subject to movement, provide bond breakers or backers. Three surface adhesion is acceptable in static joints.
- H. Structural Silicone Testing:
 - 1. Silicone joint(s) proposed for structural silicone glazing application shall be tested for performance in tension, in shear, and tension and shear combined.
 - 2. Test specimens shall be approximately 2 inches in length, full dimension in width and depth, and be composed of the specified materials, colors and finishes.
 - 3. Ten specimens for each condition shall be tested and the values for elongation-to-failure vs. stress recorded for each specimen, and the mean and standard deviation calculated for each condition.
 - 4. Tests shall be performed by the sealant manufacturer(s) whose product(s) are being considered for the structural silicone joint(s).
 - 5. In addition to the above, production test samples and testing shall be performed at regular intervals during assembly of the Work, in accordance with the recommendations of the sealant manufacturer.
 - 6. Completed glazed units shall be periodically de-glazed to confirm the homogeneity and integrity of the structural seal. De-glazing shall be performed at a rate of 1 out of the first 10 frames, followed by 1 out of the next 40 frames, followed by 1 out of the next 50 frames and 1 out of each 250 frames for the remainder of the project unless more stringent rates are recommended by the silicone manufacturer.
- I. Contractor shall provide certification from sealant manufacturer that the sealant manufacturer has reviewed all sealant details and tested all contact surfaces, and finds same suitable for use with proposed sealant, the purpose intended and compatible with the surfaces with which they are in contact. Sealant manufacturer's certification shall include the following based upon tests performed on production run materials:
 - 1. Test data of adhesion to production samples of metal and glass, tested in accordance with ASTM C 794.
 - 2. Compatibility statement that the materials in contact with the sealant such as gaskets, spacers, setting blocks, are compatible with the sealant after 21 days exposure to ultra violet, 2000 - 4000 (micro watt u.v. radiation).

3. Stress statement that when exposed to the specified wind load the stress in the silicone sealant of dimensions shown does not exceed 20 psi with a safety factor of 6:1.
- J. Where silicone bonds to a metal or glass surface, the weakest element in the line of stress must have a minimum strength of 120 psi. For each combination of substrates submit report from an independent laboratory for tests performed in the following manner:
1. Assemble and fully cure a minimum of 6 samples using actual substrates and a minimum sample length of 5".
 2. Subject sample to a tensile load such that nominal stress on silicone is 20 psi, hold for one minute and remove load. Repeat for additional loadings, increasing nominal silicone stress by 20 psi with each successive loading. Continue until failure occurs or until 200 psi is successfully applied.
 3. All 6 samples must successfully withstand at least 120 psi. Report maximum stress and mode of failure. If one or more samples do not meet this criteria, revise failed element and repeat tests with 6 new samples. Repeat until all 6 samples are successfully tested.
 4. Testing shall be performed in such a manner as to establish stress and safety factor over the temperature range described herein.
 5. Prepare an outline for a quality assurance program for evaluation of adhesion and other physical attributes of sealants and submit to Architect for review and approval.
 6. Program shall cover both initial testing of components for sealant adhesion/compatibility, etc., and also random testing of production run materials, etc.
- K. Include testing at full negative design pressure, one unit per one hundred units manufactured for the project. Also include methods which will be employed to monitor sealant application to insure full sealant contact. No sealant work shall be performed prior to approval of program.
- L. Compatibility: ASTM C1087, Submit an overall compatibility schedule for all sealants with all contact surfaces, in spreadsheet format, with written verification attached from sealant manufacturer for same. Demonstrate that all substrates are compatible with the sealant after 21 days exposure to ultra violet, 2000 - 4000 (micro watt u.v. radiation).
- M. Staining: Include ASTM C1248 stain response testing for sealant and primers in direct contact with natural stone, concrete, or wood. All structural silicone to be manufacturer standard black by default.
- N. All structural silicone to be black.
- 2.10 GLAZING
- A. Glazing: Comply with Section 08 80 10 "Exterior Glazing."

2.11 OPERABLE VENTS

- A. Four-sided structural silicone glazed, window units with no exposed outer frame, designed for glazing into curtain wall system. Window and joint between window and curtain wall shall be designed as pressure-equalized rainscreen.
- B. Performance Class and Grade: Comply with performance indicated for fixed areas of curtain wall and AAMA/WDMA/CSA 101/I.S.2/A440 as follows:
 - 1. Minimum Performance Class: AW
 - 2. Minimum Performance Grade: 50
- C. Operating Types: Provide the following operating types in locations indicated on Drawings:
 - 1. Operation: Project out Casement
- D. Frames and Sashes: Aluminum extrusions
 - 1. Thermally Broken Construction: Fabricate frames, and sashes, with an integral, concealed, low-conductance thermal barrier to meet indicated u-values and condensation resistance.
 - 2. Frames shall include 1" thermally broken lug for mounting into glazing pocket.
- E. Projected Window Hardware:
 - 1. Hardware, General: Provide hardware fabricated from aluminum, stainless steel, or other corrosion-resistant material compatible with adjacent materials; designed to smoothly operate, tightly close, and securely lock windows, and sized to accommodate sash weight and dimensions.
 - 2. Exposed Hardware Color and Finish: Stainless steel, brushed finish.
 - 3. Hinges: Heavy Duty Four bar stainless steel hinges by Truth or approved equivalent, comply with AAMA 904.1 "Specification for Multi-Bar Hinges in Window Applications".
 - 4. Latching Device: Multi-point concealed locking device with removable handle for use by maintenance personnel only.
- F. Weather Stripping: Provide two complete lines of full-perimeter weather stripping for each operable sash.
- G. Insect Screens: None:

2.12 SPANDREL WITH BACKPAN

- A. Back Pan: Galvanized steel sheet, minimum 26 gage, reinforced to comply with structural loading indicated for the exterior skin of the building. Reinforcing shall be galvanized angles adhered with double-faced tape.
 - 1. Profile shall allow for sealing of back pan into mullion opening and to seal around anchors or other obstructions.
- B. Insulation: Semi-rigid, rock or slag mineral fiber, complying with ASTM C 612, unfaced, including manufacturer's written recommended foil-tape, sealants and accessories.
 - 1. Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.
 - a. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation.
 - c. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.

2.13 SHADOW BOX

- A. Shadow box shall have three primary components; back pan, shadow box panel and insulation, plus sealant and accessories.
- B. Back Pan: Galvanized steel sheet, minimum 26 gage, reinforced to comply with structural loading indicated for the exterior skin of the building. Reinforcing shall be galvanized angles adhered with double-faced tape or other method required for fire resistive joint system.
 - 1. Profile shall allow for sealing of back pan into mullion opening.
 - 2. Pan shall be coordinated with anchors to maintain air tight enclosure control.
 - 3. Pan shall be coordinated with perimeter trim.
- C. Visible Panel: Reinforced panel fabricated from 0.25" aluminum plate.
 - 1. Mount vision panel with no exposed fasteners.
 - 2. Mounting method shall allow for weeping and ventilation of space behind panel.
 - 3. Mount signage (specified elsewhere) on vision panel with concealed fasteners.

- D. Insulation: Semi-rigid, rock or slag mineral fiber, complying with ASTM C 612, un-faced, including manufacturer's written recommended mechanical attachment, sealants and accessories.
- E. Fabrication: Form back pan watertight to profiles indicated. Reinforce panels to comply with indicated criteria. Seal all corners and intersections of back pan.
- F. Weeps and Ventilation: Provide weeping and ventilation of space behind spandrel glass and into space between solid panel and back pan.
 - 1. Vent holes shall be into glazing pocket in front of back-up weatherseal or into mullion space in front of air seal.
 - 2. Weeps shall be in glazing material at bottom horizontal mullion.
 - 3. Weeps and vents shall have filter material to eliminate dust.
 - 4. Size weeps and vents to provide for pressure-equalization of the shadow box cavity, to protect from excess heat build-up and to conform with performance requirements.
- G. Prepare curtain wall framing for light fixtures installed into shadow box specified elsewhere. Seal all penetrations to mount fixtures and at wires and conduits routed to the fixtures.

2.14 FABRICATION

- A. Fabricate frames to provide for minimal work on site.
- B. Fabricate curtain walls so that final work will comply with indicated performance criteria matching the fabrication methods used on successfully tested systems.
- C. Form or extrude aluminum shapes before finishing.
- D. Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Physical and thermal isolation of glazing from framing members.
 - 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 5. Provisions for field replacement of glazing from interior for vision glass and exterior for spandrel glazing panels.
 - 6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- E. Fabricate components to resist water penetration as specified.
- F. Fabricate to accommodate sheet metal base flashing indicated as mounted into aluminum curtain wall.

- G. Fabricate to accommodate plate cladding flashing adjacent to aluminum curtain wall.
- H. Air Barrier/Water Resistant Barrier: Inside face of glazing pocket and glazing forms a portion of air barrier/water resistant barrier system for building enclosure. Provide continuity of air barrier/ water resistant barrier system across inner face of glazing pocket. Where vapor retarder is at a location other than the inside face of glass, detail system to maintain continuity of air barrier/vapor retarder across framing members, system and connection to adjacent air barrier/vapor retarder materials
1. Fabricate curtain wall to accept sealing to adjacent air barrier membrane flashing at perimeter of glazing pocket.
 2. Mill off the tongue of mullions where necessary to provide a continuous and flat surface for perimeter silicone edge transition membrane.
- I. Interior Stool:
1. Cut extrusions to length at factory with joints designed to align with centers of mullions. De-burr, sand smooth and shop paint the cut ends. Cut ends do not have to be shop painted where end is butted against adjacent surface with a hairline joint.
 2. Provide structural support bracket.
 3. Provide splice/alignment plates behind each splice joint.
 4. Provide angle closure for mounting to floor.
- J. Brake Metal Elements:
1. Fabricate to profiles indicated and as required for performance criteria.
 2. Fold back edges or provide adhered or welded on angle at perimeter to accept sealant and backer.
 3. Fabricate back-up plates with concealed retainer clips.
 4. Reinforce to eliminate oilcanning with aluminum angles welded or adhered to back of panel.
 5. Complete welding before finishing.
 6. Fabricate anchor clips and attachments which resist loads and allow movement.
 7. At formed metal, the perimeter arris (i.e. the arris between the face plane and the edge plane) shall be consistent throughout the work. Panel sheet shall be scored and back-cut to achieve a sharp arris with a design radius not exceeding 1/16 inch.
 8. Grain of panels shall be oriented in the same direction upon installation.
 9. Panel support construction shall result in a panel visual flatness within specified tolerances.
- K. Entrances and Doors:
1. Fabricate curtain wall with frames for aluminum entrance doors sub-frames.
 2. Seal door sub-frames and frames into glazing pocket.
- L. Operable Vents: Fabricate as required to match tested performance.

1. Glaze operable vents in factory.
 2. Set operable vent frame into glazing pocket and seal.
 3. Install hardware for proper performance.
- M. Back Pans and Shadow Box: Fabricate back pans with air and watertight corners and seams.
1. Install into frames, anchor and seal perimeter and penetrations.
 2. Install semi-rigid insulation over stick pins and secure in-place. Locate stick-pins per insulation manufacturer's instructions.
 3. Seal mullion joints from face of back pan to glazing pocket.
 4. Where indicated seal from back pan into glazing pocket with silicone membrane flashing.
 5. Fabricate Shadow box panel to mount onto backpan with VHB tape or other concealed fastening. Attach signage to shadow box panel with concealed fasteners.
- N. Fabricate the following before finishing:
1. Any item that must be welded.
- O. Steel Fabrication:
1. Assemble items in the shop to greatest extent possible to minimize field splicing and assembly.
 - a. Disassemble units only as necessary for shipping and handling limitations.
 - b. Clearly mark units for reassembly and coordinated installation.
 - c. Use connections that maintain structural value of joined pieces.
 2. Form metal to required shapes and sizes, true to line and level with true curves and accurate angles and surfaces. Finish exposed surfaces to smooth, sharp, well-defined lines and arris.
 3. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.
 4. Form simple and compound curves in bars, pipe, tubing, and extruded shapes by bending members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces.
 5. 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 burrs, sharp or rough areas on all surfaces.
 6. Mill joints to a tight, hairline fit. Cope or miter corner joints. Fabricate connections that will be exposed to weather in a manner to exclude water.
 7. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.

8. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Cut, reinforce, drill, and tap as needed to receive finish hardware, screws, and similar items unless otherwise indicated.
9. Comply with AWS for recommended practices in shop welding. Clean welded joints of flux, and dress exposed and contact surfaces.
 - a. Where welding cannot be concealed behind finished surfaces, finish joints to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 Welds: no evidence of a welded joint.

- P. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.15 ALUMINUM FINISHES

A. General:

1. Shop finish Work, including surfaces not to be exposed to view in Final Work.
2. Finish aluminum to match other adjacent aluminum components.
3. Surfaces not exposed to the exterior or the interior shall receive a chemical conversion coat pretreatment associated with organic coating. All conversion coatings shall meet the minimum requirements of ASTM B 449. Approved coatings are:
 - a. Alodine as manufactured by Amchem Products, Inc.
 - b. Bonderite as manufactured by The Parker Company.

B. Exterior High-Performance Organic Finish:

1. High-Performance Organic Finish (Two-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coating; Organic Coating: manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605 and with coating and resin manufacturers' written instructions.
2. Color and Gloss: Custom color to match architects sample.

C. Interior Surfaces: Baked-Enamel or Powder-Coat Finish, AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: Match exterior.

- D. Curtain wall extrusions shall be finished prior to shop fabrication except any members that require welding or other fabrication that results in damage to finish or exposed surfaces (except for cut ends) and as otherwise indicated.
 - 1. Coat cut ends of extrusions that may be visible in the finished work with a shop or field coating system recommended by the primary coating system manufacturer.
- E. It is the intent that all other components of the curtain wall fabricated from extrusion, plate, sheet, angle, channel, tube, or other shapes shall be finished after fabrication. Items that require welding shall be finished after fabrication. Items that shall be finished after fabrication include but are not limited to:
- F. Color Consistency:
 - 1. The total color variation of any piece of coated metal included in the specifications listed above shall not vary by more than 1 Hunter DeltaE units from the approved sample for a total variation of 2 Hunter DeltaE units between the furthest variations.
 - 2. The color variation between any two pieces of coated metal included in the specifications listed above and in direct contact shall not vary by more than a total of 1 Hunter DeltaE units between the two pieces.

2.16 STEEL FINISHES

- A. General:
 - 1. Shop finish all Steel Work, including surfaces not to be exposed to view in Final Work.
 - 2. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations relative to applying primer.
 - 3. Shop prime steel after fabrication.
 - 4. Shop-prime steel surfaces, except the following:
 - a. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2".
 - b. Surfaces to be field welded.
 - c. Surfaces to be high-strength bolted with slip-critical connections, if primer does not meet the specified AISC slip coefficient.
- B. Galvanizing: Hot-dip galvanize products made from rolled, pressed, and forged steel shapes, castings, plates, bars, and strips indicated to be galvanized to comply with ASTM A123/A123M.

1. Hot-dip galvanize steel and iron hardware indicated to be galvanized to comply with ASTM A153/A153M.
 2. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
 3. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- C. Preparing Galvanized Items for Shop Priming: After galvanizing, thoroughly clean decorative metal of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.
- D. Preparing Nongalvanized Items for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
- E. Primer Application: Apply shop primer to prepared surfaces of items 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. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 2. Apply two coats of shop primer to surfaces that are inaccessible after assembly or erection.
 3. Shop prime uncoated ferrous-metal surfaces with zinc-rich primer indicated.
 4. Do not apply primer to galvanized surfaces.

2.17 FABRICATION TOLERANCES

- A. General: Comply tolerances indicated for installed work or with more stringent tolerances if required to:
1. Match approved Samples and Mock-ups.
 2. Comply with performance criteria.
 3. Comply with manufacturer's written instructions.
 4. Align with other supported or adjacent Work with more stringent tolerances.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
1. Verify dimensions, tolerances, and conditions of building structure and substrate are within specified limits.

2. Verify substrates and structure to which curtain wall will be anchored are suitable for method of attachment indicated in shop drawings.
3. Verify sills, wall openings and adjoining air and vapor seal materials are ready to receive Work of this Section.
4. Verify accurate benchmarks and layout control points.
5. Verify that adjacent waterproofing, roofing and coatings to which curtain wall is sealed are complete and watertight, including intersection with other systems.

B. Proceed with installation only after unsatisfactory conditions have been corrected

1. Commencing installation indicates acceptance of substrates, structure and adjacent conditions.

3.2 PREPARATION

- A. Prepare surfaces that are in contact with structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces
- B. Furnish inserts and embedded anchors to trades responsible for their installation. Direct locations of block-outs in concrete. Direct layout and verify accuracy.
- C. Furnish anchors shop welded to structural steel to trades responsible for their installation. Direct locations and verify layout and accuracy.

3.3 INSTALLATION

A. General:

1. Install curtain walls so that final work will comply with indicated performance criteria matching the installation methods used on successfully tested systems.
2. Install as required to match approved submittals and as required to provide performance indicated.
3. Comply with manufacturer's written instructions.
4. Do not install damaged components.
5. Fit joints to produce hairline joints free of burrs and distortion.
6. Rigidly secure nonmovement joints.
7. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
8. Where welding is required, weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
9. Seal joints watertight unless otherwise indicated.

B. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
2. Where aluminum is in contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint or other method acceptable to architect.

C. Anchors and Connections:

1. Anchors and connections shall be provided to fully satisfy their required purpose of adjustability, movement, and load transfer.
2. Connections between different materials shall be designed to allow for the differential thermal movement of the respected materials.
3. Anchors and connections that are not designed to provide for movement shall prevent such movement by appropriate means.
4. Anchors and connections that are designed for movement shall be of such construction that friction is low enough to allow for such movement without buckling and other damage and without causing binding and noises.
5. Self-drilling, self-threading fasteners shall not be permitted for use into concrete or masonry.
6. Metal surfaces shall be separated in such a manner that metal does not move on metal. Materials used for this purpose shall be low friction components, sealants or gaskets as applicable.
7. Anchorages to Structural Steel shall not induce rotational forces in supporting members.
8. All anchors, connections, and fixings outboard of the air-seal shall be 300 series stainless steel.
9. Avoid excess shimming that may induce additional stress on fasteners. The total thickness (t) of a shim pack shall not exceed a dimension equal to the diameter (d) of the fastener/anchor. Where $t > d$, the fastener/anchor shall be recalculated to take into account the additional stress from bending on the fastener with the assumption that the shim does not contribute to resistance to fastener bending. Additional stress due to bending shall be added to tension stress and the tension/shear interaction analyzed
10. Shim packs that resist compressive forces only may be high-impact plastic, Korolath type or equal. Shim packs subject to shear forces shall be stainless steel or HDG steel plates pinned together to form a monolithic shim.

D. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.

E. Install components plumb and true in alignment with established lines and grades.

F. Install glazing as specified in Section 08 80 10 "Exterior Glazing."

1. Install glass with low-e coatings in proper orientation.

2. Install with fill tubes for IGU at the top of the panel.
 3. Use torque controlled tools to produce proper compression of gaskets at pressure plates. Limit edge pressure transmitted from framing system to the edges of IGU to a maximum of 10 pounds per linear inch.
- G. Install aluminum entrances specified elsewhere in Division 8 that are mounted into the curtain wall.
- H. Install operable sash into curtain wall frames.
- I. Backpans: Install between framing and seal airtight to mullions.
- J. Install insulation: Stuff insulation tightly into cavities in thickness indicated. Keep insulation 1" away from back of glass.
1. Spandrel with backpan: Install unfaced mineral wool insulation over stick pins and secure in place.
- K. Shadow Box: Install back pan and seal intersections of all mullion framing air tight.
1. Install shadow box panel with signage attached over back pan with VHB tape or concealed fasteners.
 2. Provide weeps and vents with filters in gasketing.
- L. Silicone Edge Transition Membrane: Where indicated provide silicone membrane flashing.
1. Comply with manufacturer's instructions.
 2. Clean substrates to remove all contamination and bond breakers.
 3. Confirm substrate moisture and temperature are within manufacturer's recommended limits.
 4. Apply primer to substrates recommended by flashing manufacturer.
 5. For visible locations, mask installation area to control spillage and migration.
 6. Provide continuous adhesive/sealant to bond flashing into place.
 7. Provide bonding area shown or, if not shown, minimum 0.75 inch on each side of joint.
 8. Embed flashing into uncured, fresh adhesive/sealant.
 9. Roll installed flashings into adhesive/sealant with pressure.
 10. Hold flashing in place until adhesive/sealant grabs and holds.
 11. Complete horizontal work before vertical work.
 12. Remove masking and spilled adhesive/sealant.
 13. Provide uniform, straight, flashings free from wrinkles, fish mouths, and distortion.
 14. Provide flashings which meet manufacturer's adhesion performance.
 15. Provide 100 percent waterproof assemblies including terminations and intersections.

- M. Coordinate MEP/FP, security, lighting protection, and other services mounted on or through curtain wall.
- N. Firesafing: Refer to Section 07 84 46 Curtain Wall Joint Firestopping.
- O. Joint Sealants and Joint Fillers: Refer to Joint Sealants: Division 7.

3.4 FIELD STRUCTURAL SILICONE GLAZING

- A. Comply with requirements of curtain wall manufacturer, silicone manufacturer, IGU fabricator and applicable industry standards.
- B. For the purposes of this article, field SSG shall also apply to any aluminum frame, trim or other element structurally silicone glazed in the field in addition to IGU.
- C. Do not install IGU on any day when air temperature or surface temperature of SSG substrate is less than 40 degrees to avoid potential for ice or frost. Record air and surface temperatures are lower than 50 degrees.
- D. Complete SSG in single day. Framing surfaces for SSG shall be cleaned and primed, IGU installed and temporarily restrained with pressure plates and structural silicone material placed and tooled on the same day. Any IGU placed but SSG not completed shall be removed to allow for proper cleaning of substrates.
- E. Do not remove temporary pressure-plates for a minimum of 14 days or longer if recommended by manufacturer. Verify time with manufacturer for SSG completed in cold weather.
- F. Glazing:
 - 1. Preparation: Clean surface of substrate and glass by pouring solvent onto a clean rag, wiping vigorously and immediately wiping excess solvent away with a second clean rag.
 - 2. Priming: Prime surface of metal using a thin film adhesion promoter.
 - 3. Install spacer tape on metal frame. Apply structural silicone.
 - 4. Center lite in opening, rest on setting blocks and push glazing into sealant to provide continuous contact. Tool joint smooth and straight. Temporarily support glass until sealant sets up.
 - 5. Install glass with low-e coatings in proper orientation.
 - 6. Install with fill tubes for IGU at the top of the panel.

3.5 FIELD QUALITY CONTROL

- A. Provide daily inspection of installation per approved Curtain Wall Quality Program.

- B. Field Testing is specified in Section 01 45 25. Cooperate with testing agency and provide access.
 - 1. Glazed aluminum curtain walls will be considered defective if they do not pass tests and inspections.
- C. Comply with requirements of Division 01 Section 01 83 16 "Exterior Enclosure General Requirements" for Quality Assurance and Control procedures required for the work of the Exterior Enclosure.
- D. Installation Tolerances:
 - 1. General: Install to tolerances as required to:
 - a. Comply with tolerances indicated in Section 01 83 16.
 - b. Match approved Mockup and Samples.
 - c. Comply with performance criteria.
 - d. Comply with manufacturer's written instructions.
 - e. Achieve tolerances indicated for Final Work.
 - 2. Localized Bow and Warp of glass and IGU Panes and metal panels glazed into or mounted on curtain wall frames installed in the finished work: Glass, IGU and metal panels shall be free of bow and warp to limit visual distortion to not exceed aesthetic standards established with samples and mockups. In no case shall the tolerance for localized bow and warp exceed the lesser of the following:
 - a. 1/32" over any 12"
 - b. 5:1000 along any edge
 - c. 7:1000 along a diagonal (longest if unequal).
 - d. Maximum measured bow and warp in mockups.
- E. Structural-Sealant Adhesion: Test structural sealant according to recommendations in ASTM C 1401, Destructive Test Method A, "Hand Pull Tab (Destructive)," Appendix X2.
 - 1. Test a minimum of two areas on each building facade.
 - 2. Repair installation areas damaged by testing.

3.6 ADJUSTING

- A. Touchup damage to prefinished surfaces per recommendations of coating manufacturer. Touch ups shall be invisible in the finished work per definition of Surface Uniformity in Section 01 83 16.

3.7 CLEANING

- A. Clean per manufacturers written instructions and industry standards.
- B. Clean system periodically during construction as necessary to avoid permanent damage or staining. Inspect at least monthly to ensure no permanent damage or staining.
- C. Clean completed system, inside and out, promptly after erection and installation of glass and sealants, allowing for nominal curing of liquid sealants.
- D. Within one week before Date of Substantial Completion, clean curtainwall system thoroughly and polish glass, inside and out.
- E. Demonstrate proper cleaning methods and materials to Owner's maintenance personnel.

3.8 PROTECTION

- A. Protect Finished Work from damage immediately after erection.
- B. Protect aluminum with protective covering.
- C. Protect glass with crossed streamers attached to aluminum, not to glass.
- D. Protect glass per GANA TD-03-1003 at a minimum.

END OF SECTION

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SECTION 08 56 53
BULLET-RESISTANT (BR) WINDOWS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fixed aluminum-framed bullet-resistant (BR) windows used as storm window on existing courthouse.
2. Glazing for bullet-resistant windows.
3. Anchorage of bullet-resistant windows to rough opening.
4. Accessories as shown or as may be required in conjunction with the system or to join the system to adjacent construction.

B. Related Requirements:

1. Section 018316 "Exterior Enclosure General Requirements" for additional requirements related to the building enclosure, including but not limited to, the following:
 - a. Performance and design requirements for exterior building enclosure.
 - b. Coordination of Work required to complete the exterior enclosure.
 - c. Quality Assurance and Quality Control procedures required exterior enclosure Work.
2. Section 088010 "Exterior Glazing" for additional requirements for glazing used in BR-windows,.

1.2 REFERENCES

- A. Definitions:** Refer to Division 01 Section "Exterior Enclosure General Requirements" for definitions related to Exterior Enclosure.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:** Coordinate work of this section with adjacent components of the exterior enclosure. Participate in coordination required in Division 01 Section "Exterior Enclosure General Requirements".
1. Coordinate for color consistency of with adjacent aluminum storefront storm windows.
 2. Coordinate glass and glazing specified in 088010.

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- B. Preinstallation Meetings: Conduct as specified in Section 018316, Exterior Enclosure General Requirements.
 - 1. Preinstallation Conference: Conduct conference at Project site.
- C. Exterior Enclosure Coordination Workshops: Participate in workshops indicated in Division 01 Section "Exterior Enclosure General Requirements."
- D. Sequencing / Scheduling: Comply with requirements specified in Division 1 Section "Exterior Enclosure General Requirements".

1.4 SUBMITTAL REQUIREMENTS

- A. Submit per the requirements of Section 013300 Submittal Procedures and as indicated herein.
- B. CM shall coordinate submittals as indicated in 018316 Paragraph 1.3-C and as otherwise indicated.
- C. Organization of Packages: Complete scope of BR aluminum windows shall be submitted in a single package for the full scope of BR window work including:

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, glazing and fabrication methods, dimensions of individual components and profiles, hardware, and finishes for aluminum windows.
- B. Shop Drawings: For BR aluminum windows show fabrication and installation details, materials, dimensions, gauges, trim, fasteners, closures and finishing including all attachments and joint sealants to surrounding construction. Show how system complies with specified criteria including, but not limited to accommodation of structural movement, pressure equalization, thermal cycling and control of water penetration, air infiltration and vapor migration.
 - 1. Details: Full size details of each unique condition including heads, sills, mullions, corners, intersection with abutting construction and joints in system.
 - a. Include details cut through the end of tubular sections showing for example, closure, sealant backup, continuity of seals and anchorage at locations including but not limited to the intersection of vertical mullions with floor or threshold at doors; and at Tee or Ell intersections.
 - b. Include details cut through the ends and joints of brake metal or similar sheet fabrications showing returns, attached angles or other methods for support of sealant or connection to adjacent construction.

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2. Include each anchor and mounting device, engineered by delegated design engineer. Anchors, connections, mounting methods or other similar work noted as "BY OTHERS" will not be acceptable.
 3. Include accessories, flashing, and sealant installation.
 4. Shop drawings shall identify every gasket and sealant required for indicated performance. Gaskets and sealants cannot be indicated as "by others".
 5. Show sufficient information to trace continuity of inner and outer line of seals, (rain screen and air barrier), to trace line of thermal barrier and to trace continuity of vapor retarder if location differs from inner seal.
 6. Shop drawings must show the shop drawing of the adjacent construction in which the BR windows are mounted for coordination.
 7. The shop drawings and the delegated design calcs shall include every anchor, screw, fastener, clip and similar accessory. The shop drawings cannot indicate that these are by others.
- C. Samples for Verification: For aluminum windows and components required, submit samples of size indicated below:
1. Exposed Finishes: **12 by 12 inches or 12 inch long sections of actual extrusions.**
 2. Exposed Hardware: Full-size units.

1.6 DELEGATED DESIGN SUBMITTALS

- A. Delegated-Design Submittal: For BR aluminum windows 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. Bullet-Resistance: Include analysis for loading related to bullet-resistance and transfer of loads to rough opening.
 2. Wind Loading: Include analysis from manufacturers data or from calculations showing ability to resist wind loads.
 3. Cross-reference calculations to exact elevations or details in the shop drawings. Calculations with generic or non-specific cross-references will be returned without action.
 4. Submit calculations with shop drawings and other submittals required of this section.
 5. Anchors: Include analysis of the anchors which attach the systems to adjacent construction or structure. Analyze and identify every anchor, bolt, screw, clip, fastener or similar device for fixing the curtain wall in place. These cannot be indicated as "By others".
 - a. Delegated Design Engineer shall indicate selection of proprietary anchors including but not limited to embedded slot anchors, cast-in anchors, chemical anchors, undercut anchors, and wedge anchors based on manufacturers test data and requirements for loading.

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1.7 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each type of BR aluminum window, for tests performed by a qualified testing agency.
 - 1. Include certified laboratory test reports from an accredited independent testing agency indicating compliance with specified performance requirements.
 - 2. Windows included in test reports shall match proposed windows shown in shop drawing.
- B. Installation Instructions: Manufacturer's standard installation instructions for the windows and accessories used for this project.
- C. Re-glazing Methodology: Instructions for re-glazing of structural silicone glazing and standard glazing in the field to replace broken glass.
- D. Sample Warranties: For manufacturer's warranties.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer capable of fabricating aluminum windows that meet or exceed performance requirements indicated and of documenting this performance by test reports and calculations.
- B. Installer Qualifications: An installer acceptable to aluminum window manufacturer for installation of units required for this Project.
- C. Delegated Design Engineer: Professional Engineer, licensed in State of Delaware and having a minimum of five (5) years documented experience designing systems similar to those required for this Project. Delegated Design Engineer shall sign and seal calculations and shop drawings.
- D. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
 - 3. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
 - 4. AWS D1.6, "Structural Welding Code - Stainless Steel."

1.9 DELIVERY, STORAGE AND HANDLING

- A. Package, deliver, load and unload, store and protect windows according to AAMA CW-10.

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1.10 WARRANTY

- A. Special Assembly Warranty: Manufacturer, fabricator, and installer agrees to repair or replace windows that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Noise or vibration created by wind and thermal and structural movements.
 - c. Water penetration through glazing and framing areas.
 - d. Water penetration at interface of windows and accessories with adjacent walls.
 - e. Failure of operating components.
 2. Include glass and glazing Special Project Warranty specified in Section 080010.
 3. Warranty Period: Two years from date of Substantial Completion except as indicated for glass.
- B. Manufacturer's Warranty on Structural Silicone Glazing: Provide written Warranty signed by manufacturer of structural silicone agreeing to replace structural silicone sealants not performing to specified criteria. Deterioration of structural silicone glazing is defined as cohesion or adhesion failure not attributed to substrate failure.
1. Warranty Period: 10 years from date of Substantial Completion.
- C. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Warranty Period: 20 years from date of Substantial Completion.
- D. Special Finish Warranty (Interior Surfaces): Standard form in which coating manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period when used on the interior of the building.
1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.

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- b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
2. Warranty Period: 10 years for AAMA 2603 finish from date of Substantial Completion for finish exposed to interior conditions only.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design aluminum windows with all accessories included in this specification section.
- 1. Design each anchor bolt, screw or other device to attach work of this section to adjacent construction.
 - 2. Verify ganged or mulled units meet performance requirements or design reinforcing.
 - 3. Provide thermal movement analysis based on criteria indicated.
- B. General Performance: Comply with performance requirements specified, as determined by testing of window and terrace doors representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
- 1. Comply with requirements of Section 018316 Exterior Enclosure General Requirements and additional criteria indicated.
 - 2. Windows 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.
 - 3. 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: Comply with ASCE 7 for Cladding and Component loads per criteria shown on S-001
- 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 amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than **1/8 inch**.
- E. Bullet Resistance: Provide units identical to those tested for compliance with requirements indicated, and as follows:
 1. Ballistics Resistance: Listed and labeled as Level 7 minimum for frame when tested according to UL 752.
- F. Thermal Movements: Provide BR-aluminum windows, including anchorage, that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 1. Temperature Change: **120 deg F** ambient; **180 deg F** material surfaces.

2.2 MANUFACTURERS/PRODUCTS

- A. Basis of Design: Subject to compliance with requirements, provide the following: Bullet Block HP 600 by Insulgard Security Products or approved equivalent.
- B. Source Limitations: Obtain all BR aluminum windows from single source from single manufacturer.
- C. Customize existing systems to meet the indicated requirements.
 1. Obtain custom-fabricated sills, trim, and accessories from window manufacturer as indicated on drawings.

2.3 BULLET RESISTANT FIXED ALUMINUM WINDOWS

- A. Frames: Fabricate from aluminum extrusions, **ASTM B221**, provide alloy and temper recommended by manufacturer for strength, corrosion resistance, and application of required finish, but not less than **22,000-psi** ultimate tensile strength
 1. Reinforce frames with thickened aluminum, stainless steel, hot-dipped galvanized steel, or composite materials for bullet resistance criteria.
 2. Profile of frame shall match profile of adjacent aluminum storefront storm windows within 1/4".
- B. Glazing System: Match glazing system used in mockups that validate tested performance.

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- C. Concealed Flashing: Aluminum or dead-soft, 0.018-inch- thick stainless steel, ASTM A 240/A 240M of type recommended by manufacturer.

2.4 BULLET RESISTANT GLAZING

- A. Glass Products: As specified in Section 088010.
- B. Meet minimum indicated bullet resistance indicated.
- C. Glass: 1.93" glass-clad polycarbonate, Basis of Design: Armor-Gard BALULN50 by Insulgard Security Products.
- D. BR glazing: Glazing shall consist of multiple laminated layers of glass, polycarbonate, and interlayers complying with ASTM C1349 Standard Specification for Architectural Flat Glass Clad Polycarbonate
 - 1. Glass shall be low-iron ultra clear.
 - 2. Glass shall be heat-strengthened or heat-soaked fully tempered as required for performance.
 - 3. Polycarbonate and interlayers shall be clear.
 - 4. Thickness as required for specified criteria.
- E. Fire-Test-Response Characteristics of Polycarbonate Sheets: As determined by testing polycarbonate sheets identical to those used in BR glazing products by a qualified testing agency acceptable to authorities having jurisdiction.
 - 1. Self-ignition temperature of 650 deg F (343 deg C) or more when tested according to ASTM D1929 on plastic sheets in thicknesses indicated for the Work.
 - 2. Smoke-Developed Index of 450 or less when tested according to ASTM E84, or smoke density of 75 or less when tested according to ASTM D2843 on plastic sheets in thicknesses indicated for the Work.
 - 3. Burning extent of 1 inch (25 mm) or less when tested according to ASTM D635 at a nominal thickness of 0.060 inch (1.52 mm) or thickness indicated for the Work.
- F. Glazing Sealant:
 - 1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they contact, including BR glazing and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
 - 2. Suitability: Comply with sealant and security glazing manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
 - 3. Adhesion and Compatibility Testing: Test each security glazing type, tape sealant, gasket, glazing accessory, and glazing-framing member for adhesion to and compatibility with elastomeric glazing sealants.

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- a. Testing will not be required if data based on previous testing of current sealant products and glazing materials match those submitted.
 - b. Use ASTM C1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to security glazing, tape sealants, gaskets, and glazing channel substrates.
 - c. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
 - d. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 - e. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.
- G. Glazing Accessories: Comply with requirements of Section 088010 for glazing tapes, gaskets, cleaners, primers, setting blocks, spacers, edge blocks, joint backing, and other accessories necessary to complete the work.
- H. Fabricate BR glazing in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
1. Grind smooth and polish exposed BR glazing edges and corners.

2.5 ACCESSORIES

- A. Fasteners and Accessories: Stainless steel 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. If exposed use fasteners with countersunk Phillips screw heads, finished to match framing system.
 4. Materials: Stainless steel, ASTM F 593 and F 594, Alloy Group 1.
- B. Spray Foam Insulating Sealant: Minimal expanding, polyurethane foam, classified as a sealant per UL R13655. Closed cell content minimum 80% per ASTM D 2856, Flame spread less than 25, smoke development less than 450 per ASTM E 84.
1. Basis of Design: Dow Great Stuff Pro Window and Door or equivalent.
- C. Filters: Silicone compatible PVC-coated reticulated open cell polyurethane foam, 30 to 40 pores per 1 linear inch sized for installation at 30-50 percent compression.
1. Provide PVC Coated SIF-G Industrial Foam by Stephenson and Lawyer, Inc or equivalent.

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D. Coatings:

1. Shop Primer for Steel: Zinc dust rich primer SSPC Paint 20 or Paint 29 Organic zinc-rich epoxy coating.
2. Touch-up Primer for Galvanized Steel: Primer with minimum 80 percent zinc in dry film complying with SSPS 20.
3. Dissimilar Metal Coating: Cold-applied asphalt mastic complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat or other non-conductive, non-absorptive material.

E. Foam Tape: 9 pcf density (self-adhesive) foam tape with flame retardants to meet FMVSS 302 flammability standard. Norton V 780 or approved substitution. Provide tape 1 inch wide, unless otherwise indicated by the following thickness.

1. Provide 1/8 inch thick at metal panels, concrete or other smooth substrate.
2. Provide 1/4 inch thick at masonry or similar rough substrate.

2.6 FABRICATION

A. General: Fabricate BR windows to provide a complete system for assembly of components and anchorage of window units.

1. Factory fabricate to greatest extent possible to minimize work in field.
2. Provide units that are reglazable from the secure side without dismantling the attack side of framing.
3. Prepare security windows for field glazing unless preglazing at the factory is indicated.

B. Provide weep holes and internal water passages for exterior BR windows to conduct infiltrating water to the exterior.

C. Framing: Miter or cope corners the full depth of framing; weld and dress smooth or reinforce corners for mechanical fixing.

1. Fabricate framing with internal opaque armoring in thicknesses required for BR windows to comply

D. Welding: Weld components to comply with referenced AWS standard. To greatest extent possible, weld before finishing and in concealed locations to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

E. Metal Protection: Separate dissimilar metals to protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.

F. Fabricate windows so that final work will comply with indicated performance criteria matching the fabrication methods used on successfully tested windows.

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- G. Fabricate sill pieces with end dams and other pieces indicated with end dams. Either turn up the end dam and seal corners or provide a separate end dam piece pop-riveted and sealed to sill.
- H. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.
- I. Fabricate sheet metal and brake metal trim with sharp corners per SMACNA. Fabricate closures for ends of units. Turn up or apply separate angles to support sealant and backer rod at ends or edges of shapes that abut other construction.
- J. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.

2.7 GENERAL FINISH REQUIREMENTS

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

2.8 ALUMINUM FINISHES

- A. Comply with requirements indicated in Section 018316 for Coated Metal Color Control in addition to requirements specified herein for coordination, sourcing limits, color variation tolerances, etc.
- B. General:
 - 1. Shop finish Work, including surfaces not to be exposed to view in Final Work.
 - 2. Finish aluminum to match other adjacent aluminum components.
 - 3. Surfaces not exposed to the exterior or the interior shall receive a chemical conversion coat pretreatment associated with organic coating. All conversion coatings shall meet the minimum requirements of ASTM B 449. Approved coatings are:
 - a. Alodine as manufactured by Amchem Products, Inc.
 - b. Bonderite as manufactured by The Parker Company.
- C. High-Performance Organic Finish:

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1. High-Performance Organic Finish (Two-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coating; Organic Coating: manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than **70** percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605 and with coating and resin manufacturers' written instructions.
 2. Color and Gloss: Match adjacent windows.
- D. Window extrusions shall be finished prior to shop fabrication except any members that require welding or other fabrication that results in damage to finish or exposed surfaces (except for cut ends) and as otherwise indicated. Coat any cut ends of extrusions that may be visible in the finished work with a shop or field coating system recommended by the primary coating system manufacturer.

2.9 STEEL FINISHES

A. General:

1. Shop finish all Steel Work, including surfaces not to be exposed to view in Final Work.
2. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations relative to applying primer.
3. Shop prime steel after fabrication.
4. Shop-prime steel surfaces, except the following:
 - a. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2".
 - b. Surfaces to be field welded.
 - c. Surfaces to be high-strength bolted with slip-critical connections, if primer does not meet the specified AISC slip coefficient.

B. Galvanizing: Hot-dip galvanize products made from rolled, pressed, and forged steel shapes, castings, plates, bars, and strips indicated to be galvanized to comply with ASTM A123/A123M.

1. Hot-dip galvanize steel and iron hardware indicated to be galvanized to comply with ASTM A153/A153M.
2. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
3. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

C. Preparing Galvanized Items for Shop Priming: After galvanizing, thoroughly clean decorative metal of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.

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- D. Preparing Nongalvanized Items for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
- E. Primer Application: Apply shop primer to prepared surfaces of items 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. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 - 2. Apply two coats of shop primer to surfaces that are inaccessible after assembly or erection.
 - 3. Shop prime uncoated ferrous-metal surfaces with zinc-rich primer indicated.
 - 4. Do not apply primer to galvanized surfaces.

2.10 FABRICATION TOLERANCES

- A. General: Comply tolerances indicated for installed work or with more stringent tolerances if required to:
 - 1. Match approved Samples and Mock-ups.
 - 2. Comply with performance criteria.
 - 3. Comply with manufacturer's written instructions.
 - 4. Align with other supported or adjacent Work with more stringent tolerances.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Verify rough opening dimensions, levelness of sill plate, and operational clearances.
- C. Examine wall flashings, air barriers, water and weather barriers, and other built-in components to ensure weathertight window installation.
- D. Inspect built-in and cast-in anchor installations, before installing security windows, to verify that anchor installations comply with requirements. Prepare inspection reports.
 - 1. Remove and replace anchors where inspections indicate that they do not comply with specified requirements. Reinspect after repairs or replacements are made.
 - 2. Perform additional inspections to determine compliance of replaced or additional work. Prepare anchor inspection reports.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

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3.2 PREPARATION

- A. Coordination: Furnish layouts for cast-in-place anchors, clips, and other BR window anchors whose installation is specified in other Sections.
 - 1. Furnish cast-in-place anchors and similar devices to other trades for installation well in advance of time needed for coordinating other work.
- B. Do not commence installation of units until sills are properly prepared.

3.3 INSTALLATION

- A. General:
 - 1. Install BR window frames and glazing so that final work will comply with indicated performance criteria matching the installation methods used on successfully tested systems.
 - 2. Install as required to match approved submittals and as required to provide performance indicated.
 - 3. Do not install damaged components.
 - 4. Fit joints to produce hairline joints free of burrs and distortion.
 - 5. Rigidly secure nonmovement joints.
 - 6. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
 - 7. Seal joints watertight unless otherwise indicated.
- B. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E 2112.
- C. Install windows and window surrounds level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.
- D. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.
- E. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

3.4 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of security glazing, sealants, gaskets, and other glazing materials unless more stringent requirements are indicated, including those in referenced glazing publications.

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- B. Protect edges of security glazing from damage during handling and installation. Remove damaged security glazing from Project site and legally dispose of off Project site. Damaged security glazing includes units with edge or face damage or other imperfections that, when installed, could weaken security glazing and impair performance and appearance.
- C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications unless otherwise required by glazing unit manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- E. Do not exceed edge pressures stipulated by security glazing manufacturers for installing lites.
- F. Provide spacers for security glazing lites where the length plus width is larger than 50 inches (1270 mm).
 - 1. Locate spacers directly opposite each other on both inside and outside faces of security glazing. Install correct size and spacing to preserve required face clearances unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with performance requirements.
 - 2. Provide 1/8-inch (3-mm) minimum bite of spacers on glazing lites and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- G. Provide edge blocking where indicated or needed to prevent security glazing from moving sideways in glazing channel, as recommended in writing by security glazing manufacturer and according to requirements in referenced glazing publications.
- H. Set security glazing in each series with uniform pattern, draw, bow, and similar characteristics.
- I. 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.
- J. 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.

3.5 FIELD QUALITY CONTROL

- A. Testing is specified in Section 014525.
 - 1. Windows will be considered defective if they do not pass tests and inspections.

2. Retesting and additional new testing as indicated for failed tests.
- B. Comply with requirements of Division 01 Section "Exterior Enclosure General Requirements" for Quality Assurance and Control procedures required for the work of the Exterior Enclosure.
- C. Installation Tolerances:
 1. General: Install to tolerances as required to comply with the strictest of the following:
 - a. Comply with tolerances indicated in Section 018316.
 - b. Match approved Mockup and Samples.
 - c. Comply with performance criteria.
 - d. Comply with manufacturer's written instructions.

3.6 ADJUSTING, CLEANING, AND PROTECTION

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

END OF SECTION

NOT FOR BID

SECTION 08 71 00

DOOR HARDWARE

PART 1 – GENERAL

1.01 SUMMARY

- A. Section includes hardware for doors specified in “Hardware Sets”.
- B. Related Divisions:
 - 1. Division 03 Concrete
 - 2. Division 06 Rough & Finish Carpentry
 - 3. Division 08 Openings
 - 4. Division 09 Finishes
 - 5. Division 26 Electrical
 - 6. Division 27 Communications
 - 7. Division 28 Electronic Safety and Security

1.02 REFERENCES

- A. American National Standards Institute/Builders Hardware Manufacturers Association (ANSI):
 - 1. ANSI/BHMA A156.1 Butts & Hinges (2016)
 - 2. ANSI/BHMA A156.2 Bored & Preassembled Locks & Latches (2017)
 - 3. ANSI/BHMA A156.3 Exit Devices (2020)
 - 4. ANSI/BHMA A156.4 Door Controls – Closers (2019)
 - 5. ANSI/BHMA A156.5 Cylinders and Input Devices for Locks (2020)
 - 6. ANSI/BHMA A156.6 Architectural Door Trim (2015)
 - 7. ANSI/BHMA A156.7 Template Hinge Dimensions (2016)
 - 8. ANSI/BHMA A156.8 Door Controls – Overhead Stops and Holders (2015)
 - 9. ANSI/BHMA A156.13 Mortise Locks & Latches (2017)
 - 10. ANSI/BHMA A156.18 Materials & Finishes (2020)
 - 11. ANSI/BHMA A156.21 Thresholds (2019)
 - 12. ANSI/BHMA A156.22 Door Gasketing Systems (2017)
 - 13. ANSI/BHMA A156.25 Electrified Locks (2018)
 - 14. ANSI/BHMA A156.26 Continuous Hinges (2017)
 - 15. ANSI/BHMA A156.28 Keying Systems (2018)
 - 16. ANSI/BHMA A156.35 Power Supplies for Electronic Access Control (2020)
- B. International Code Council/American National Standards Institute (ICC/ANSI)/ADA:
 - 1. ICC/ANSI A117.1 Standards for Accessible and Usable Buildings and Facilities.
- C. Door and Hardware Institute (DHI):
 - 1. DHI Publication – Abbreviations and Symbols (2019).
 - 2. DHI Publication – Installation Guide for Doors and Hardware (2020).
 - 3. DHI Publication – Sequence and Format of Hardware Schedule (2019).
- D. National Fire Protection Agency (NFPA):
 - 1. NFPA 70 National Electrical Code.
 - 2. NFPA 80 Standard for Fire Doors and Other Opening Protectives.
 - 3. NFPA 105 Standard for the Installation of Smoke Door Assemblies.

1.03 SUBMITTALS

- A. Submit in accordance with Conditions of the Contract and Division 01 Administrative Requirements and Submittal Procedures Section.
- B. Shop Drawings:
 - 1. Schedule hardware in vertical format using the DHI publication Sequence and Formatting for the Hardware Schedule.
 - 2. Include abbreviations and symbols page to include manufacturers' abbreviations, finish code descriptions, and fastener abbreviations including descriptions according to the DHI publication Abbreviations and Symbols.
 - 3. Detail headings referencing the Architect's heading, opening number, locations, fire rating, handing, degree of opening, and description of the opening elements. Include Voltage, amperage, and operational descriptions for openings that have electrified hardware.
 - 4. Coordinate final door hardware schedule with doors, frames, and related work listing proper sizing of hardware, addressing door thickness, handing, function, mounting accessories, and finish of hardware.
 - 5. List related door devices specified in other Sections for each opening.
 - 6. Architectural Hardware Consultant (AHC), as certified by DHI, who will affix seal attesting to completeness and correctness, including the review of the hardware schedule prior to submittal.
- C. Product Data:
 - 1. Furnish manufacturers' catalog sheets on design, grade, and function of items listed in hardware schedule. Submit only relevant information and circle or highlight the technical information including: model numbers, sizing information, voltage and amperage requirements, options and accessories required, means of fastening, listings of fire-rated applications, and finishes.
- E. Templates:
 - 1. Within fourteen days of receiving approved door hardware submittals submit complete list of templates for each hardware item to the opening manufacturers and the installers. Include detailed lists of the hardware location requirements for mortised and surface applied hardware.
- F. Wiring Diagrams: Detail a title block for each drawing that includes the project name, project address, architect name, architect's opening number, hardware set, date, and name of the author.
 - 1. Elevation Riser Drawings:
 - a. Furnish one set of elevation drawings with each hardware schedule submittal for hardware sets that contain electrified hardware. Illustrate the openings with proportional representations of the opening and electrified hardware components and dimension their mounting locations as well as sizes of junction boxes and power supplies. Label the components, wire quantities and gauges, high voltage requirements, as well as other building interfaces. Create a legend that complements the drawings with brand names, model numbers, and include voltage and amperage requirements. Add an operational description that includes the normal state of the door, ingress, egress, and what happens in case of power loss or fire alarm activation and any special conditions.
 - b. Upon receipt of approved hardware correct and resubmit elevation drawings with the point-to-point and system drawings.
 - 2. Point-to-Point and System Drawings: Upon receipt of approved hardware schedule, submit point-to-point per hardware set and a system drawing. Cross-reference all wiring diagrams and the associated drawings to each other.
 - a. Point-to-Point Drawings: Draw each product in a realistic representation including each terminal including those not used, and lines representing wires from component to component, labeling wire colors and gauges.
 - b. System Drawing: illustrate all equipment and building interfaces required for the entire system. Include room labels and locations, opening numbers and locations.
- G. Closeout Submittals: Include the following information as well as highlight and flag fire rated openings for annual inspections:
 - 1. Cover page with required information:
 - a. Project name

- b. Hardware supplier's name and contact information.
 - c. Date of substantial completion.
2. Final record hardware schedule.
3. Product Data.
4. Keying Schedule.
5. Record Wiring Diagrams.
 - a. System Drawing.
 - b. Elevations.
 - c. Point-to-Point Drawings with all final wire colors noted as terminated. (Include network IP and/or MAC addresses of field devices).
6. Operating and Maintenance Manual.
7. Warranty Information.

1.04 QUALITY ASSURANCE

- A. Hardware supplier shall employ an Architectural Hardware Consultant (AHC) as certified by DHI and a member of the seal program who will be available at reasonable times during course of work for Project hardware consultation.
 1. Electrified Door Hardware Supplier Qualifications: Experienced door hardware supplier who has completed projects with electrified door hardware similar in material, design, and extent to that is indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
 2. Access and Electrified Security Supplier Qualifications: Experienced supplier who has completed projects with access and electrified security door hardware similar in material, design, and extent to that is indicated for this Project, whose work has resulted in construction with a record of successful in-service performance and be a factory authorized distributor.
- B. Where openings are required to be accessible door hardware shall conform to ICC/ANSI A117.1.
- C. Fire Rated Door Assemblies: Where fire-rated door assemblies are indicated, provide door hardware complying with NFPA 80 that are listed and/or labeled by a qualified testing agency for fire-protection ratings indicated.
- D. Smoke and Draft Control Door Assemblies: Where smoke and draft control doors are required, provide door hardware that meets requirements of assemblies in compliance with NFPA 105.
- E. Door hardware certified to ANSI/BHMA standards as noted, manufacturer must participate and be listed in BHMA Certified Products Directory.
- F. Substitution requests shall be submitted in compliance with Division 01: create a comparison chart that includes the testing information as well as the warranty for both the specified product and the proposed substitution. Include the reason for requesting the substitution, clear catalog copy highlighting the proposed product and options, compliance statement, technical data, product warranty and lead time, to show how the proposed can meet or exceed established level of design, function, and quality.
 1. Items listed with no substitute manufacturers have been requested by the Owner to meet existing standard and will not be reviewed for substitution unless the product is no longer available.
- G. Meetings: Comply with requirements in Division 01 Section "Project Meetings."
 1. Low-voltage Coordination Meeting
 - a. Prior to furnishing door hardware submittals, convene a low-voltage coordination meeting. Meeting participants should include all affected trades including the following, but not limited to: Contractor, installer, supplier, electrical contractor, security consultant and installer, Owner's IT representative, and fire alarm consultant.
 - b. Review sequence of operation for each opening with electrified hardware to ensure that every opening functions properly for the Owner's use.

- c. Discuss the types of electrified door hardware, inspection, and electrical roughing-in and other preparatory work performed by other trades.
- d. Verify wire quantities, wire types, wire sizes, conduit sizes, and locations including if the power supplies will be centrally located or if they will be located near each opening.
- e. Coordinate the door hardware, power supplies, back-up power requirements, access control components, fire alarm interfaces, elevator controls, and related building systems have all proper and necessary components to interface and operate correctly.

2. Keying Meeting

- a. Within fourteen days of receiving approved door hardware submittals, contact Owner to establish a keying conference. Include keying meeting decisions into final keying schedule submittal after reviewing the following, but not limited to:
 - ii. Function of the building, flow of traffic, individual area's purpose, and degree of security.
 - iii. Lock functions and operation.
 - iv. Preliminary key system schematic diagram.
 - v. Verify existing keyway(s), and/or proposed keyway(s)
 - vi. Visual key and cylinder identification
 - vii. Quantity of keys required including master level keys, change keys, and keys per lock.
 - viii. Review the key control system.
 - ix. Determine the recipient and contact information for the delivery of keys and accessories.

3. Pre-installation Meeting

- a. Convene meeting within fourteen days of receiving approved door hardware submittals. Participants from all affected buildings trades shall attend. Minimum participants should include: Contractor, installer, material supplier, manufacturer representatives, electrical contractor, security consultant, and fire alarm consultant.
- b. Inspect and discuss preparatory work performed by other trades.
- c. Include in-conference decisions regarding proper installation methods and procedures for receiving and handling hardware.
- d. Review all system, elevation, and point-to-point drawings to ensure that all necessary components are provided and detailed.
- e. Review and finalize construction schedule and verify availability of materials, installer's personnel, equipment, and facilities needed to make progress and avoid delays.
- f. Review required testing, inspecting, and certifying procedures.

H. Installer Qualifications: Specialized in performing installation of this Section and have five years minimum documented experience.

- 1. Electrified Hardware Supplier Qualifications: Experienced door hardware installer who has installed projects with electrified door hardware similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- 2. Access Control and Electrified Security Supplier Qualifications: Experienced installer who has completed projects with access and electrified security door hardware similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance and be a factory authorized to install and commission the system.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Pack each item complete with necessary parts and fasteners in manufacturer's original packaging.
- B. Mark hardware that is not bulk packed with architect's opening number, hardware set number, and item number for each type of hardware. Include keyset symbols and corresponding hardware component for keyed products. Mark hardware that is bulk packed with manufacturers' part number and reference all hardware sets associated.
- C. Deliver hardware to the job site according to the phasing agreed upon in the pre-installation meeting. Inventory the delivery with the supplier's assistance. Immediately note shortages and damages on the shipping receipts and bill of lading. Coordinate replacement or repair with the supplier.

- D. Deliver permanent keys, cores, access control credentials, software, and related accessories directly to Owner via registered mail or overnight package service. Establish the instructions for delivery to Owner at "Keying Conference."
- E. Provide a clean, dry, and secure room for hardware delivered. Shelf hardware off the floor and with larger items of hardware stored on pallets. Arrange locksets and keyed cylinders by opening number. Organize the balance of hardware by brand, model of hardware, and hardware set number. Leave the door markings of the hardware visible for installers.
- F. Waste Management and Disposal: Separate waste materials for use or recycling in accordance with Division 01.

1.06 WARRANTY

- A. General Warranty: Comply Division 01 for Warranty requirements.
- B. Special Warranty: Warranties specified in this article will not deprive Owner of other rights.
 - 1. Ten years for manual door closers.
 - 2. Five years for locks.
 - 3. Five years for exit devices.
 - 4. One year for electromechanical door hardware.
 - 5. All access and electrified security equipment and systems will be warranted for a period of one (1) year commencing with the filing date of the Notice of Completion, provided the system has been inspected and signed off by a factory authorized installer and the factory authorized commissioning agent.

1.07 MAINTENANCE

- A. Maintenance Tool and Instructions: Furnish a complete set of specialized tools and maintenance instructions for Owner's continued adjustment, maintenance, removal, and replacement of door hardware.

PART 2 – PRODUCTS

2.01 HINGES

- A. Hinges, electric hinges, and self-closing hinges of one manufacturer as listed for continuity of design and consideration of warranty.
- B. Standards: Products to be certified and listed by the following:
 - 1. Butts and Hinges: ANSI/BHMA A156.1.
 - 2. Template Hinge Dimensions: ANSI/BHMA A156.7.
 - 3. Self-Closing Hinges: ANSI/BHMA A156.17.
- C. Butt Hinges:
 - 1. Hinge weight and size unless otherwise indicated in hardware sets:
 - a. Doors up to 36" wide and up to 1-3/4" thick provide hinges with a minimum thickness of .134" and a minimum of 4-1/2" in height.
 - b. Doors from 36" wide up to 42" wide and up to 1-3/4" thick provide hinges with a minimum thickness of .145" and a minimum of 4-1/2" in height.
 - c. For doors from 42" wide up to 48" wide and up to 1-3/4" thick provide hinges with a minimum thickness of .180" and a minimum of 5" in height.
 - d. Doors greater than 1-3/4" thick provide hinges with a minimum thickness of .180" and a minimum of 5" in height.
 - e. Width of hinge is to be minimum required to clear surrounding trim.
 - 2. Base material unless otherwise indicated in hardware sets:
 - a. Exterior Doors: 304 Stainless Steel, Brass or Bronze material.
 - b. Interior Doors: Steel material.
 - c. Fire Rated Doors: Steel or 304 Stainless Steel materials.

- d. Stainless Steel ball bearing hinges to have stainless steel ball bearings. Steel ball bearings are unacceptable.
- 3. Quantity of hinges per door unless otherwise stated in hardware sets:
 - a. Doors up to 60" in height provide 2 hinges.
 - b. Doors 60" up to 90" in height provide 3 hinges.
 - c. Doors 90" up to 120" in height provide 4 hinges.
 - d. Doors over 120" in height add 1 additional hinge per each additional 30" in height.
 - e. Dutch doors provide 4 hinges.
- 4. Hinge design and options unless otherwise indicated in hardware sets:
 - a. Hinges are to be of a square corner five-knuckle design, flat button tips and have ball bearings unless otherwise indicated in hardware sets.
 - b. Out-swinging exterior and out-swinging access-controlled doors are required to have Non-Removable Pins (NRP) to prevent removal of pin while door is in closed position.
 - c. When full width of opening is required, use hinges that are designed to swing door completely from opening when door is opened to 95 degrees.
 - d. When shims are necessary to correct frame or door irregularities, provide metal shims only.

5. Acceptable Manufacturers:

	Standard Weight	Heavy Weight
Hager	AB700	AB750
Bommer		
McKinney		

2.02 CONTINUOUS HINGES

- A. Continuous hinges of one manufacturer as listed for continuity of design and consideration of warranty.
- B. Standards: Products to be certified and listed by ANSI/BHMA A156.26 Grade 1.
- C. Continuous Geared Hinges:
 - 1. Determine model number by door and frame application, door thickness, frequency of use, and fire rating requirements according to manufacturer's recommendations.
 - a. Size length of hinge to equal the actual door height unless otherwise stated in hardware sets.
- D. Material and Design:
 - 1. Base material: Anodized aluminum manufactured from 6063-T6 material; unexposed working metal surfaces be coated with TFE dry lubricant.
 - 2. Bearings:
 - a. Vertical loads be carried on Lubriloy RL bearings for non-fire rated doors.
 - b. Continuous hinges are to have a minimum spacing between bearings of 2-9/16". Typical door from 80" to 84" in height to have a minimum of 32 bearings.
 - 3. Options:
 - a. Provide factory-cut preparations for concealed electric power transfers.
 - b. When full width of opening is required, use hinges that are designed to swing door completely from opening when door is opened to 95 degrees.
 - c. At fire rated openings provide hinges that carry a UL certification, up to and including 90-minute applications for wood doors and up to 3-hour applications for metal doors.

E. Acceptable Manufacturers:

	Heavy Duty
Hager	780-111HD/780-112HD
Bommer	FMHD/FMSLFHD
Zero	914A/910A

2.03 FLUSH BOLTS AND COORDINATORS

- A. Flush bolts of one manufacturer as listed for continuity of design and consideration of warranty.
- B. Standards: Manufacturer to be listed by the following: Auxiliary Hardware: ANSI/BHMI A156.16.
- C. Labeled openings: Provide automatic or constant latching flush bolts per hardware schedule for inactive leaf of pairs of doors. Provide dust proof strikes for bottom bolt.
- D. Non-Labeled openings: Provide two flush bolts for inactive leaf of pairs of doors per hardware schedule. Provide extension rods so that the center line of the top flush bolt is not more than 78" above the finish floor. Provide dust proof strike from bottom bolt.

E. Acceptable Manufacturers:

	Manual Flush Bolt	Auto Flush Bolt	Dust Proof Strike
Hager	282D	292D/295W/296W	280X
Rockwood	555	1942	570
Trimco	3917	3815	3911

- F. Coordinators: Provide for labeled pairs of doors with automatic flush bolts or with vertical rod exit device with a mortise-locking device per hardware schedule. Provide filler piece to extend full width of stop on frame. Provide mounting brackets for closers and special preparation for latches where applicable.

G. Acceptable Manufacturers:

	Coordinator	Bracket	Bracket for stops greater than 2-1/4."
Hager	297	297M	297N
Rockwood	1600	1601AB	1601C
Trimco	3094	3095	3096

2.04 LOCKS AND LATCHES

- A. Locks and latches of one manufacturer as listed for continuity of design and consideration of warranty.
- B. Standards: Product to be certified and listed by following:
1. ANSI/BHMA A156.13 Series 1000 Certified to Grade 1 for Operational and Security.
 2. UL/cUL Labeled and listed up to 3 hours for single doors up to 48" in width and up to 96" in height.
 3. UL10C/UBC 7-2 Positive Pressure Rated.
 4. ICC/ANSI A117.1.
- C. Lock and latch function numbers and descriptions of manufacturer's series as listed in hardware sets.
- D. Material and Design:
1. Lock cases from fully wrapped, 12-gauge steel, zinc dichromate for corrosion resistance.
 2. Non-handed, field reversible without opening lock case.
 3. Break-away spindles to prevent unlocking during forced entry or vandalism.
 4. Levers, zinc cast, forged brass or stainless steel and plated to match finish designation in hardware sets.
 5. Sectional Roses, solid brass or stainless-steel material and have a minimum diameter of 2-7/16".
 6. Armor fronts, self-adjusting to accommodate a square edge door or a standard 1/8" beveled edge door.
- E. Latch and Strike:
1. Stainless steel latch bolt with minimum of 3/4" throw and deadlocking for keyed and exterior functions.
 2. Strike is to fit a standard ANSI A115 prep measuring 1-1/4" x 4-7/8" with proper lip length to protect surrounding trim.

- Deadbolts to be 1-3/4" total length with a minimum of a 1" throw and 3/4" internal engagement when fully extended and made of stainless-steel material.

F. Electrified Locks

- Fail-Safe (power lock): Outside trim is locked when power is applied and unlocked when power is removed. Lockset will unlock in the event of a power failure (EL).
- Fail-Secure (power unlock): Outside trim is locked when there is no power and unlocked when power is applied. Lockset will be locked in the event of a power failure (EU).
- Latch bolt monitoring: Single switch SPDT mounted inside lockset monitors full extension of latch bolt (LM).
- Door Position Monitor: Single switch SPDT reed magnetic switch mounted inside lockset monitors whether door is fully closed (DPM).
- Request to Exit: Monitors inside lever rotation (RX).

G. Acceptable Manufacturers:

Hager	3800 Series
Best	45H Series
Sargent	8200 Series

2.05 EXIT DEVICES

- A. Exit Devices of one manufacturer as listed for continuity of design and consideration of warranty. Touchpad type, finish to match balance of door hardware.
- B. Standards: Manufacturer to be certified and/or listed by the following:
- BHMA Certified ANSI A156.3 Grade 1.
 - UL/cUL Listed for up to 3 hours for "A" labeled doors.
 - UL10C/UBC 7-2 Positive Pressure Rated.
 - UL10B Neutral Pressure Rated.
 - UL 305 Listed for Panic Hardware.
- C. Material and Design:
- Provide exit devices with actuators that extend a minimum of one-half of door width.
 - Where trim is indicated in hardware sets provide the lever design to match design of lock levers.
 - Exit device to mount flush with door.
 - Latchbolts:
 - Rim device – 3/4" throw, Pullman type with automatic dead-latching, stainless steel
 - Surface vertical rod device – Top 1/2" throw, Pullman type with automatic dead-latching, stainless steel. Bottom 1/2" throw, Pullman type, held retracted during door swing, stainless steel.
 - Fasteners: Wood screws, machine screws, and thru-bolts.
- D. Lock and Latch Functions: Function numbers and descriptions of manufacturer's series and lever styles indicated in door hardware sets.

E. Acceptable Manufactures:

Hager	4500 Series	4600 Series
Von Duprin	99 Series	33 Series
Sargent	80 Series	8500 Series

F. Electric Modifications:

1. Motorized Latch Retraction (MLR): An electric motor retracts the latch bolt for momentary or maintained periods of time.
2. Provide Request to Exit (REX) switches as scheduled.
3. Electrified Trim: Outside trim locked (EL) or unlocked (EU) by electric current.
4. Delayed Egress with Wall Mounted Controller (Hager Model 2-679-0630) (DE).

2.06 CYLINDERS AND KEYING

- A. Cylinders of one manufacturer as listed for continuity of design and consideration of warranty.
- B. Products to be certified and listed by the following:
1. Auxiliary Locks: ANSI/BHMA A156.5
- C. Cylinders:
1. Provide cylinders matched to the types required for hardware that has a locking function and for keyed electronic functions. Furnish with appropriate collars, cams, and tailpieces to fit and operate associated hardware. Stacking collars is not acceptable, a single collar of proper size is required.
 2. Manufacturer's seven-pin small format interchangeable core (SFIC).
 3. Provide concealed key control (CKC) at cylinder by stamping or permanently marking the keyset symbol in a location on the cylinder that is concealed when installed.
- D. Keying:
1. Key into Owner's existing key system.
 2. Provide a bitting list to Owner of combinations as established, and expand to twenty-five percent for future use or as directed by Owner.
 - a. Include all of the keysets and bittings of the original key system creating one clean version of the entire key system.
 3. Keys to be shipped directly to the Owner's Representative as established during the keying conference.
 - a. Package the keys in individual envelopes, grouped by keyset symbol, and label envelopes with project name, factory registry number, and keyset symbol.
 4. Stamp large bow key blanks with visual key control (keyset symbol) and "Do Not Duplicate".
 5. Provide interchangeable cores with construction cores as required per the keying meeting.
 6. Single seven-pin key will operate both conventional cores and SFIC small format interchangeable cores.
- E. Acceptable Manufacturers:

Best

2.07 PUSH/PULL PLATES AND BARS

- A. Push/Pull plates and bars of one manufacturer as listed for continuity of design and consideration of warranty.
- B. Standards: Manufacturer to be certified by the following:
1. Architectural Door Trim: ANSI/BHMA A156.6.
 2. Americans with Disabilities Act Accessibility Guidelines (ADAAG).
- C. Push plates: .050" thick, square corner and beveled edges with countersunk screw holes. Width and height as stated in hardware sets.
- D. Acceptable Manufacturers:

Hager	30S
Rockwood	

Trimco	

- E. Pull Plates: .050" thick, square corner and beveled edges. Width and height as stated in hardware sets, 3/4" diameter pull, with clearance of 2-1/2" from face of door.

- F. Acceptable Manufacturers:

Hager	H34J
Rockwood	
Trimco	

2.08 CLOSERS

- A. Closers of one manufacturer as listed for continuity of design and consideration of warranty, unless otherwise indicated on hardware schedule, comply with manufacturer's recommendations for size of closer, depending on width of door, frequency of use, atmospheric pressure, ADAAG requirement, and fire rating.
- B. Standards: Manufacturer to be certified and or listed by the following:
1. BHMA Certified ANSI A156.4 Grade 1.
 2. ADA Complaint ANSI A117.1.
 3. UL/cUL Listed up to 3 hours.
 4. UL10C Positive Pressure Rated.
 5. UL10B Neutral Pressure Rated.
- C. Material and Design:
1. Provide cast iron non-handed bodies with full plastic covers.
 2. Closers will have separated staked adjustable valve screws for latch speed, sweep speed, and backcheck.
 3. Provide Tri-Pack arms and brackets for regular arm, top jamb, and parallel arm mounting.
 4. One-piece seamless steel spring tube sealed in hydraulic fluid.
 5. Double heat-treated steel tempered springs.
 6. Precision-machined heat-treated steel piston.
 7. Triple heat-treated steel spindle.
 8. Full rack and pinion operation.
- D. Mounting:
1. Out-swing doors use surface parallel arm mount closers except where noted on hardware schedule.
 2. In-swing doors use surface regular arm mount closers except where noted on hardware schedule.
 3. Provide brackets and shoe supports for aluminum doors and frames to mount fifth screw.
 4. Furnish drop plates where top rail conditions on door do not allow for mounting of closer and where backside of closer is exposed through glass.
- E. Size closers in compliance with requirements for accessibility (ADAAG). Comply with following maximum opening force requirements.
1. Interior hinged openings: 5.0 lbs.
 2. Fire-rated and exterior openings use minimum opening force allowable by authority having jurisdiction.
- F. Fasteners: Provide self-reaming, self-tapping wood and machine screws, and sex nuts and bolts for each closer.

- G. Acceptable manufacturers:

Hager	5100 Series
LCN	4040XP Series
Sargent	281 Series

2.09 PROTECTIVE TRIM

- A. Protective trim of one manufacturer as listed for continuity of design and consideration of warranty.
- B. Size of protection plate: single doors, size two inches less door width (LDW) on push side of door, and one inch less door width on pull side of door. For pairs of doors, size one inch less door width (LDW) on push side of door, and 1/2 inch on pull side of door. Adjust sizes to accommodate accompanying hardware, such as, edge guards, astragals, and others.
1. Kick Plates 10" high or sized to door bottom rail height.
 2. Mop Plates 4" high.
 3. Armor Plates 36" high.
- C. Products to be certified and listed by the following:
1. Architectural Door Trim: ANSI/BHMA A156.6.
 2. UL.
- D. Material and Design:
1. 0.050" gage stainless steel.
 2. Corner's square, polishing lines, or dominant direction of surface pattern so they run across door width of plate.
 3. Bevel top, bottom, and sides uniformly leaving no sharp edges.
 4. Countersink holes for screws. Space screw holes so they are no more than eight inches CTC, along a centerline not over 1/2" in from edge around plate. End screws maximum of 0.53" from corners.
- E. UL label stamp required on protection plates when top of plate is more than 16 inches above bottom of door on fire rated openings. Verify door manufacturer's UL listing for maximum height and width of protection plate to be used.

F. Acceptable Manufacturers:

Hager	190S
Trimco	
Burns	

2.10 STOPS AND HOLDERS

- A. Stops and holders of one manufacturer as listed for continuity of design and consideration of warranty.
- B. Wall Stops: Provide door stops wherever necessary to prevent door or hardware from striking an adjacent partition or obstruction. Provide wall stops when possible. Door stops and holders mounted in concrete floor or masonry walls have stainless steel machine screws and lead expansion shields.
- C. Products to be certified and listed by the following:
1. Auxiliary Hardware: ANSI/BHMA A156.16.
- D. Acceptable Manufacturers:
- | | Convex | Concave |
|----------|--------|---------|
| Hager | 232W | 236W |
| Rockwood | | |
| Burns | | |
- E. Overhead Stops and Holders: Provide overhead stops and holders for doors that open against equipment, casework sidelights and other objects that would make wall stops/holders and floor stops/holders inappropriate. Provide sex bolt attachments for mineral core wood door applications.
- F. Products to be certified and listed by the following:
1. Overhead Stops and Holders: ANSI/BHMA A156.8 Grade 1.

G. Acceptable Manufacturers:

	Heavy Duty Surface	Heavy Duty Concealed
Hager	7000 SRF Series	7000 CON Series
Glynn Johnson	90 SRF Series	100 Series
Sargent	590 Series	690 Series

2.11 ELECTROMAGNETIC HOLDERS

A. Electromagnetic holders of one manufacturer as listed for continuity of design and consideration of warranty.

B. Products to be certified and listed by the following:

1. ANSI A156.15 Grade 1.
2. UL/ULC Listed.
3. California State Fire Marshall listed (CSFM).
4. City of New York MEA approved.

C. Material and Design:

1. Provide electromagnetic holders where self-closing fire doors and smoke barrier doors are required to be held open. Electromagnetic holders to be fail-safe: when electrical current is interrupted, doors release to close automatically. Holding force 25-40 lbs.

D. Acceptable Manufacturers:

Hager	380 Series
LCN	
Rixson	

2.12 POWER TRANSFER

A. Power transfer of one manufacturer as listed for continuity of design and consideration of warranty.

B. Products to be certified and listed by the following:

1. UL Listed Miscellaneous Fire Door Accessories.
2. UL 10C Listed for up to 3 hours on fire-rated doors and frames.
3. Classified according to Uniform Building Code (UBC) Standard 7-2, Fire Test of Door Assemblies (1997).

C. Design:

1. Stainless steel tubular wire transfer and cast housing with steel back boxes to provide weather and tamper resistance when door is open or closed.
2. Mortise door and frame installation
3. Two 18 ga wires, 5 amps @ 12/24 VAC/DC.

D. Acceptable Manufacturers:

	2 conductor	10 conductor
Hager	2-679-0621 US28	2-679-0623 US28
SDC	PTM-2	PTM-10

2.13 MODULAR ACCESS CONTROL POWER SUPPLIES

A. Power supplies of one manufacturer as listed for continuity of design and consideration of warranty.

B. Products to be certified and listed by the following:

1. UL Listed.

C. Design:

1. Use with modular access control systems.
2. Field selectable filtered and regulated 12 VDC or 24 VDC constant voltage.
3. 1-, 2-, 4-, and 6-AMP load capacities. Match the power supply amperage to the total load of the opening /system plus an additional thirty percent to cover line drop, as well as possible expansion.
4. Circuit breaker protected AC input voltage; secondary output PTC protected.
5. Fire alarm input provides simultaneous release of fail-safe locks and holders.
6. Interface relay.
7. LED status indicators provide information regarding AC input, DC output, and battery backup status.
8. Separate inputs for activation switch on entry and egress and ingress side of opening.
9. 5-amp hour battery backup.
10. Input 115 VAC (230 VAC optional).
11. Optional dual 12 VDC or 24 VDC output.
12. Optional power supply monitor module to monitor power supply status, A/C power, and D/C output and battery Status

D. Include optional modules as required to properly interface, control, and sequence the hardware with the access control system.

E. Acceptable Manufacturer:

Hager	2908	1 Amp
	2909	2 Amp
	2910	4 Amp
	2911	6 Amp

2.14 THRESHOLDS

- A. Thresholds of one manufacturer as listed for continuity of design and consideration of warranty.
- B. Set thresholds for exterior and acoustical openings in full bed of sealant with lead expansion shields and stainless-steel machine screws complying with requirements specified in Division 7 Section "Joint Sealants: Notched in field to fit frame by hardware installer. Refer to Drawings for special details.
- C. Standards: Manufacturer to be certified by the following:
1. Thresholds: ANSI/BHMA A156.21.
 2. American with Disabilities Act Accessibility Guidelines (ADAAG).

D. Acceptable Manufacturers:

Hager	413S/520S
K.N. Crowder	
Reese	

2.15 DOOR GASKETING AND WEATHERSTRIP

- A. Door gasketing and weatherstrip of one manufacturer as listed for continuity of design and consideration of warranty.
- B. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing where indicated on hardware schedule. Provide noncorrosive fasteners for exterior applications.
1. Perimeter gasketing: Apply to head and jamb, forming seal between door and frame.
 2. Meeting stile gasketing: Fasten to meeting stiles, forming seal when doors are in closed position.
 3. Door bottoms: Apply to bottom of door, forming seal with threshold or floor when door is in closed position.
 4. Sound Gasketing: Cutting or notching for stop mounted hardware not permitted.
 5. Drip Guard: Apply to exterior face of frame header. Lip length to extend 4" beyond width of door.

- C. Products to be certified and listed by the following:
1. Door Gasketing and Edge Seal Systems: ANSI/BHMA A156.22.
 2. BHMA certified for door sweeps, automatic door bottoms, and adhesive applied gasketing.
- D. Smoke-Labeled Gasketing: Comply with NFPA 105 listed, labeled, and acceptable to Authorities Having Jurisdiction, for smoke control indicated.
1. Provide smoke-labeled gasketing on 20-minute rated doors and on smoke rated doors.
- E. Fire-Rated Gasketing: Comply with NFPA 80 listed, labeled, and acceptable to Authorities Having Jurisdiction, for fire ratings indicated.
- F. Refer to Section 08 1416 Wood Doors for Category A or Category B. Comply with UBC 7-2 and UL10C positive pressure where frame applied intumescent seals are required.

G. Acceptable Manufacturers:

1. Perimeter Gasketing:

	Stop Applied	Adhesive Applied
Hager	881S	726
K.N. Crowder		
Reese		

2. Sound Seal:

Hager	864S
K.N. Crowder	
Reese	

3. Meeting Stile Weatherstrip:

Hager	872SN
K.N. Crowder	
Reese	

4. Overlapping Astragal:

Hager	835S / 874SN
K.N. Crowder	
Reese	

5. Door Bottom Sweeps:

Hager	750S / 770SV
K.N. Crowder	
Reese	

6. Overhead Drip Guard

Hager	810S
K.N. Crowder	
Reese	

2.16 DOOR POSITION SWITCHES

- A. Provide door position switches for openings that require door monitoring.

B. Acceptable Manufacturers:

Non-Rated	Hager 2-679-0626

Fire Rated	GRI 184-12

2.17 SILENCERS

- A. Where smoke, light, or weather seal are not required, provide three silencers per single door frame, two per double door frame and four per Dutch door frame.
- B. Products to be certified and listed by the following:
1. Auxiliary Hardware: ANSI/BHMA A156.16
- C. Acceptable Manufacturers:

	Hollow Metal Frame	Wood Frame
Hager	307D	308D
Rockwood		
Trimco		

2.18 KEY CABINET

- A. Provide key cabinet; surface mounted to wall.
- B. Key control system:
1. Include two sets of key tags, hooks, labels, and envelopes.
 2. Contain system in metal cabinet with baked enamel finish.
 3. Capacity will be able to hold actual quantities of keys, plus 50 percent.
 4. Provide tools, instruction sheets, and accessories required to complete installation.
- C. Acceptable Manufacturers:

Lund Equipment
Telkee Incorporated
Key Control

2.19 FINISHES

- A. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if within range of approved samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within range of approved samples.
- B. Comply with base material and finish requirements indicated by ANSI/BHMA A156.18 designations in hardware schedule.

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Examine doors and frames, with installers present, for compliance with requirements for installation tolerances, labeled fire-rated construction, wall and floor construction, and other conditions affecting performance.
- B. Where hardware will be installed directly on walls inspect applications for blocking material of sufficient type and size for hardware.
- C. Examine roughing-in and cabling for electrical power systems to verify actual locations of wiring connections and wiring supplied matches the requirements as described in the wiring diagrams before electrified door hardware installation.

- D. Perform a site survey to determine proper mounting locations for all wirelessly communicating devices. Verify that the surrounding construction and equipment will not interfere with the communication between components.
- E. Where existing products will be reused, examine existing door and frame sizes, preps, swings, ratings, and compare to the specified hardware for compatibility and functionality. The hardware set specified should act as guide for design and function. Provide filler plates as needed to fill and repair existing materials. Test any existing to remain hardware for functionality and visually inspect for damage. Note any defective or damaged products as well as noting any code deficiencies and submit issues and estimated costs for direction of how to proceed with repair or replacement.
- F. Notify Architect via a prepared written report and endorsed by installer of any discrepancies between the door schedule, door types, drawings, and scheduled hardware. List conditions detrimental to application, to the proper and timely completion of the work and performance of the hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.02 INSTALLATION

- A. Install hardware using manufacturers' recommended fasteners and installation instructions, at height locations and clearance tolerances that comply with:
 - 1. NFPA 80
 - 2. NFPA 105
 - 3. ICC/ANSI A117.1
 - 4. DHI Publication – Installation Guide for Doors and Hardware
 - 5. Approved shop drawings
 - 6. Approved hardware schedule
- B. Install soffit mounted gaskets prior to other soffit mounted hardware ensuring a continuous seal around the perimeter of the opening without cutting or notching.
- C. Locate surface mounted door closers on stairwell side of stair doors, interior side of exterior openings, or on the room side of openings, unless it is a sterile room.
- D. Locate wall mounted bumper to contact the operating trim. Verify that pushbuttons of locksets do not contact the stop and inadvertently lock the door.
- E. Mount armor, mop, and kick plates flush with the bottom of the door and centered horizontally on the door.
- F. Notch thresholds with no larger than a 1/32-inch gap matching the frame profile. Set in a full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants" forming a tight seal between threshold and mounting surface. Caulk and seal the entire perimeter to prevent water leakage. Remove excess sealants immediately and clean the area thoroughly.
- G. Do not install surface mounted items until finishes have been completed on substrates involved. Set unit level, plumb and true to line location.
- H. Locate power supplies and junction boxes as directed and verified in the low-voltage coordination meeting.
- I. Perform final connections of the system components to match the approved operational narratives. Use cable markers to label wires at each termination or end to match the final wiring diagrams. Terminate wiring in accordance with the manufacturer's recommendations. Where quick-connects are seated correctly. Provide wire ties and adhesive pads to secure and organize wires in enclosures. Outside of enclosures seal terminations in waterproof connectors. Include record drawings of the point-point and the elevations in a plastic sleeve attached to the inside cover of the power supply/junction box enclosure for the Owner's use.

3.03 FIELD QUALITY CONTROL

- A. Schedule a final walk through to inspect hardware installation ten (10) business days before final acceptance of the Owner. Visually inspect for proper fasteners and verify that doors open, close, latch properly, and that openings are installed to meet NFPA 80 and ANSI A117.1 requirements. Correct deficiencies, including missing hardware immediately. Provide a written report detailing discrepancies of each opening within five (5) business days of the walk through.
- B. Prior to receiving certificate of occupancy have doors inspected by a Certified Fire and Egress Door Assembly Inspector (CFDAI), as certified by Intertek (ITS), submit a written report to the Owner and Contractor. Doors failing inspection must be adjusted, modified, or replaced to be within appropriate code requirements without delay.
- C. Test the functionality of electrified openings upon completion of the installation in accordance with the description of operation and the Owner's intent under the supervision of a factory authorized representative and an Owner's representative, verify that all features of the software are working correctly, including interfaces with any associated trades. Document the result of all tests and provide these results to the Owner and correct immediately.

3.04 ADJUSTMENT, CLEANING, AND DEMONSTRATING

- A. Prior to final adjustments, the HVAC system must be completed and balanced. Test that all openings meet ANSI A117.1 for closer opening pressure, closing speed, latching, and hardware operating forces. Replace items that cannot be adjusted to operate freely and smoothly or as intended for application.
- B. Prior to final walk-through inspection, clean adjacent surfaces soiled by hardware installation. Clean finish hardware per manufacturer's instructions after final adjustments have been made. Remove all protection and replace items that cannot be cleaned to manufacturer's level of finish quality.
- C. Demonstration and training will be conducted as per the following sessions. All sessions will be recorded and turned over to the Owner for future use.
 - 1. Hardware Maintenance: Conduct a training class for building maintenance personnel demonstrating the adjustment, operation, and maintenance of mechanical and electrified hardware. Special tools for finish hardware to be turned over and demonstrated usage at the meeting.
 - 2. Key control system: Train the Owner's designated representative on the key control system demonstrating the permanent file keys, duplicate loaner keys, key receipts, key envelopes, key change identification sheets, bitting lists, tags, and labels. When key management software is provided training will be provided for the setup and usage of the software.
 - 3. Access control: Demonstrate the management and programming of the access control system including the following, but not limited to:
 - a. System administration personnel to manage the LAN and databases including updating, maintaining, and backing up the system and database software.
 - b. Instruct on all software features and programming for managing the credentials, users, access points, time zones, alarms and events, door monitoring, audit trails, and time schedules.

3.05 PROTECTION

- A. Leave manufacturer's protective film intact and, protect exit devices, locks, and surface mounted hardware with kraft paper or bubble wrap. Cover fire labels at painted products that bear a label with magnetic or masking tape. Keep protection in place until time of final cleaning and adjustment.

3.06 HARDWARE SET SCHEDULE

- A. Door hardware items have been placed in sets which are intended to be a guide of design, grade, quality, function, operation, and performance.
1. Review products that may require mounting accessories to meet door, frame, and swing conditions as these final details vary from manufacturer to manufacturer and provide as required.
 2. Where additional items of hardware are required for completion of the Work, a written statement of such omission, error, or other discrepancy is required to be submitted to the Architect, prior to bid date for clarification via an addendum.
 3. Abbreviations listed below do not appear in the manufacturer's literature, for any other abbreviations refer to manufacturer's literature.:
 - a. LDW = Less than Door Width
 - b. LAR = Length as Required
 - c. QTY = Quantity
 - d. CTC = Centerline to Centerline
 - e. BTB = Back-to-Back mounting

3.07 HARDWARE SCHEDULE

Hardware Sets

Set #01

Doors: 101, 104, 108, 120A, 200, 201C, 250A, 250B, 257A, 314, 336C, 337A, E001, E002, E005, E011, R001

1 Cylinder Housing(s)	3901/3902 SFIC (as req'd)	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Balance of Hardware	By Door Mfr/Supplier		

Set #02

Doors: E003, E007

1 Continuous Hinge(s)	780-111HD x LAR	CLR	HA
1 Exit Device(s)	4501 RIM FEC	US32D	HA
1 Night Latch Trim(s)	45NL WLM	US26D	HA
1 Rim Cylinder(s)	3901 SFIC	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Overhead Stop(s)	7016 SRF	US32D	HA
1 Drop Plate(s)	5114	ALM	HA
1 Closer(s)	5100	ALM	HA
1 Kick Plate(s)	190S 10" x 2" LDW	US32D	HA
1 Threshold	413S x LAR	MIL	HA
1 Weatherstrip	881S N x LAR	MIL	HA
1 Door Sweep(s)	770S V x LAR	MIL	HA
1 Door Position Switch(es)	2-679-0626		HA
1 Rain Drip	810S x LAR	MIL	HA
1 Wiring Diagrams	Wiring Diagrams		

NOTE: Operational Description
Door monitored by access control system

Set #03

Doors: E004

1 Continuous Hinge(s)	780-111HD x LAR EPT/Prep	CLR	HA
1 Power Transfer(s)	2-679-0623	ALM	HA
1 Exit Device(s)	4501 RIM F MLRX FEC	US32D	HA
1 Night Latch Trim(s)	45NL WLM	US26D	HA
1 Rim Cylinder(s)	3901 SFIC	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Overhead Stop(s)	7016 SRF	US32D	HA
1 Drop Plate(s)	5114	ALM	HA
1 Closer(s)	5100	ALM	HA
1 Kick Plate(s)	190S 10" x 2" LDW	US32D	HA
1 Threshold	413S x LAR	MIL	HA
1 Weatherstrip	881S N x LAR	MIL	HA
1 Door Sweep(s)	770S V x LAR	MIL	HA
1 Rain Drip	810S x LAR	MIL	HA
1 Door Position Switch(es)	2-679-0626		HA
1 Power Supply	2908/2909/2910/2911 As Required	No Finish	HA
1 Reader/Keypad	By Security Provider		
1 Wiring Diagrams	Wiring Diagrams		

Set #03

NOTE: Operational Description
Door normally closed and locked
Entry by valid credential
Free egress at all times
Door remains locked upon power failure
Door is monitored by access control system

Set #04

Doors: E006

1	Continuous Hinge(s)	780-111HD x LAR	CLR	HA
1	Exit Device(s)	4501 RIM F FEC	US32D	HA
1	Night Latch Trim(s)	45NL WLM	US26D	HA
1	Rim Cylinder(s)	3901 SFIC	US26D	HA
1	Construction Core(s)	3982-BLU	BLU	HA
1	Core(s)	Interchangeable Core	626	BE
1	Overhead Stop(s)	7016 SRF	US32D	HA
1	Drop Plate(s)	5114	ALM	HA
1	Closer(s)	5100	ALM	HA
1	Kick Plate(s)	190S 10" x 2" LDW	US32D	HA
1	Threshold	413S x LAR	MIL	HA
1	Weatherstrip	881S N x LAR	MIL	HA
1	Door Sweep(s)	770S V x LAR	MIL	HA
1	Rain Drip	810S x LAR	MIL	HA
1	Door Position Switch(es)	2-679-0626		HA
1	Wiring Diagrams	Wiring Diagrams		

NOTE: Operational Description
Door monitored by access control system

Set #05

Doors: E008

1	Continuous Hinge(s)	780-111HD x LAR	CLR	HA
1	Exit Device(s)	4501 RIM FEC	US32D	HA
1	Night Latch Trim(s)	45NL WLM	US26D	HA
1	Rim Cylinder(s)	3901 SFIC	US26D	HA
1	Construction Core(s)	3982-BLU	BLU	HA
1	Core(s)	Interchangeable Core	626	BE
1	Overhead Stop(s)	7016 SRF	US32D	HA
1	Drop Plate(s)	5114	ALM	HA
1	Closer(s)	5100	ALM	HA
1	Kick Plate(s)	190S 10" x 2" LDW	US32D	HA
1	Threshold	413S x LAR	MIL	HA
1	Weatherstrip	881S N x LAR	MIL	HA
1	Door Sweep(s)	770S V x LAR	MIL	HA
1	Rain Drip	810S x LAR	MIL	HA

Set #06

Doors: E009

Set #06

1 Continuous Hinge(s)	780-111HD x LAR	CLR	HA
1 Continuous Hinge(s)	780-111HD x LAR EPT/Prep	CLR	HA
1 Power Transfer(s)	2-679-0623	ALM	HA
1 Automatic Flush Bolt Set	292D	US32D	HA
1 Dust Proof Strike	280X	US26D	HA
1 Electrified Lockset	3880ELEU SECT WLM RX SFIC7	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Coordinator	297D x LAR	BLACK	HA
2 Mounting Bracket(s)	297M/297N (as required)	BLACK	HA
2 Closer(s)	5100 HD	ALM	HA
2 Kick Plate(s)	190S 10" x 1" LDW	US32D	HA
2 Convex Wall Stop(s)	232W	US32D	HA
1 Seal	726 x LAR	S	HA
2 Door Position Switch(es)	2-679-0626		HA
1 Power Supply	2908/2909/2910/2911 As Required	No Finish	HA
1 Reader/Keypad	By Security Provider		
1 Wiring Diagrams	Wiring Diagrams		

NOTE: Operational Description
Door normally closed and locked
Entry by valid credential
Free egress at all times
Door remains locked upon power failure
Door is monitored by access control system

Set #07

Doors: E010

3 Hinge(s)	AB750 4 1/2" x 4 1/2" NRP	US26D	HA
1 Storeroom Lockset	3880 SECT WLM SFIC7	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Closer(s)	5100 HD	ALM	HA
1 Kick Plate(s)	190S 10" x 2" LDW	US32D	HA
1 Convex Wall Stop(s)	232W	US32D	HA
3 Silencers	307D	GREY	HA

Set #08

Doors: 312, 335B, C303, E012, U101, U109, U110A, U112, XU401, C101A

3 Hinge(s)	AB750 4 1/2" x 4 1/2" NRP	US26D	HA
1 Power Transfer(s)	2-679-0623	ALM	HA
1 Electrified Lockset	3880ELEU SECT WLM RX SFIC7	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Closer(s)	5100 HD	ALM	HA
1 Kick Plate(s)	190S 10" x 2" LDW	US32D	HA
1 Convex Wall Stop(s)	232W	US32D	HA
1 Seal	726 x LAR	S	HA
1 Door Position Switch(es)	2-679-0626		HA
1 Power Supply	2908/2909/2910/2911 As Required	No Finish	HA
1 Reader/Keypad	By Security Provider		
1 Wiring Diagrams	Wiring Diagrams		

Set #08

NOTE: Operational Description
Door normally closed and locked
Entry by valid credential
Free egress at all times
Door remains locked upon power failure
Door is monitored by access control system

Set #09

Doors: 116, E013, U102, U103, U205, U211, U212, XU402

3 Hinge(s)	AB700 4 1/2" x 4 1/2"	US26D	HA
1 Storeroom Lockset	3880 SECT WLM SFIC7	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Closer(s)	5100	ALM	HA
1 Kick Plate(s)	190S 10" x 2" LDW	US32D	HA
1 Convex Wall Stop(s)	232W	US32D	HA
3 Silencers	307D	GREY	HA

Set #10

Doors: E014

2 Continuous Hinge(s)	780-111HD x LAR	CLR	HA
1 Manual Flush Bolt Set	282D	US26D	HA
1 Dust Proof Strike	280X	US26D	HA
1 Storeroom Lockset	3880 SECT WLM SFIC7	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Overhead Stop(s)	7016 SRF	US32D	HA
NOTE: RHR Leaf			
1 Drop Plate(s)	5114	ALM	HA
1 Closer(s)	5100	ALM	HA
2 Kick Plate(s)	190S 10" x 1" LDW	US32D	HA
2 Floor Stop	252F	US26D	HA
1 Threshold	413S x LAR	MIL	HA
1 Weatherstrip	881S N x LAR	MIL	HA
2 Door Sweep(s)	770S V x LAR	MIL	HA
1 Astragal	874S N x LAR	MIL	HA
1 Rain Drip	810S x LAR	MIL	HA

Set #11

Doors: 107A, 107B, U208, U209, U304, U305

3 Hinge(s)	AB700 4 1/2" x 4 1/2" NRP	US26D	HA
1 Power Transfer(s)	2-679-0623	ALM	HA
1 Electrified Lockset	3880ELEU SECT WLM RX SFIC7	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Closer(s)	5100	ALM	HA
1 Kick Plate(s)	190S 10" x 2" LDW	US32D	HA
3 Silencers	307D	GREY	HA
1 Door Position Switch(es)	2-679-0626		HA
1 Power Supply	2908/2909/2910/2911 As Required	No Finish	HA
1 Reader/Keypad	By Security Provider		
1 Wiring Diagrams	Wiring Diagrams		

Set #11

NOTE: Operational Description
Door normally closed and locked
Entry by valid credential
Free egress at all times
Door remains locked upon power failure
Door is monitored by access control system

Set #12

Doors: U110B, U111A, U108

6 Hinge(s)	AB700 4 1/2" x 4 1/2" NRP	US26D	HA
1 Power Transfer(s)	2-679-0623	ALM	HA
1 Automatic Flush Bolt Set	292D	US32D	HA
1 Dust Proof Strike	280X	US26D	HA
1 Electrified Lockset	3880ELEU SECT WLM RX SFIC7	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Coordinator	297D x LAR	BLACK	HA
2 Mounting Bracket(s)	297M/297N (as required)	BLACK	HA
2 Closer(s)	5100 HD	ALM	HA
2 Kick Plate(s)	190S 10" x 1" LDW	US32D	HA
2 Convex Wall Stop(s)	232W	US32D	HA
1 Seal	726 x LAR	S	HA
2 Door Position Switch(es)	2-679-0626		HA
1 Power Supply	2908/2909/2910/2911 As Required	No Finish	HA
1 Reader/Keypad	By Security Provider		
1 Wiring Diagrams	Wiring Diagrams		

NOTE: Operational Description
Door normally closed and locked
Entry by valid credential
Free egress at all times
Door remains locked upon power failure
Door is monitored by access control system

Set #13

Doors: C201

4 Hinge(s)	AB750 4 1/2" x 4 1/2" NRP	US26D	HA
1 Exit Device(s)	4501 RIM FEC	US32D	HA
1 Classroom Exit Trim(s)	45CE WLM	US26D	HA
1 Mortise Cylinder(s)	3902 SFIC	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Closer(s)	5100 HDCS	ALM	HA
1 Kick Plate(s)	190S 10" x 2" LDW	US32D	HA
3 Silencers	307D	GREY	HA

Set #14

Doors: 331, 333A

Set #14

3 Hinge(s)	AB750 4 1/2" x 4 1/2" NRP	US26D	HA
1 Power Transfer(s)	2-679-0623	ALM	HA
1 Electrified Lockset	3880ELEU SECT WLM RX SFIC7	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Closer(s)	5100 HDCS	ALM	HA
1 Kick Plate(s)	190S 10" x 2" LDW	US32D	HA
1 Convex Wall Stop(s)	232W	US32D	HA
1 Seal	726 x LAR	S	HA
1 Door Position Switch(es)	2-679-0626		HA
1 Power Supply	2908/2909/2910/2911 As Required	No Finish	HA
1 Reader/Keypad	By Security Provider		
1 Wiring Diagrams	Wiring Diagrams		

NOTE: Operational Description
Door normally closed and locked
Entry by valid credential
Free egress at all times
Door remains locked upon power failure
Door is monitored by access control system

Set #15

Doors: X337

4 Hinge(s)	AB750 5" x 4 1/2" NRP	US26D	HA
1 Power Transfer(s)	2-679-0623	ALM	HA
1 Exit Device(s)	4501 RIM MLRX FEC	US32D	HA
1 Night Latch Trim(s)	45NL WLM	US26D	HA
1 Rim Cylinder(s)	3901 SFIC	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Closer(s)	5100 HD	ALM	HA
1 Kick Plate(s)	190S 10" x 2" LDW	US32D	HA
1 Convex Wall Stop(s)	232W	US32D	HA
3 Silencers	307D/308D as req'd	GREY	HA
1 Door Position Switch(es)	2-679-0626		HA
1 Power Supply	2908/2909/2910/2911 As Required	No Finish	HA
1 Reader/Keypad	By Security Provider		
1 Wiring Diagrams	Wiring Diagrams		

NOTE: Operational Description
Door normally closed and locked
Entry by valid credential
Free egress at all times
Door remains locked upon power failure
Door is monitored by access control system

Set #16

Doors: SA.1, SB.2, SB.3

Set #16

3 Hinge(s)	AB750 4 1/2" x 4 1/2"	US26D	HA
1 Exit Device(s)	4501 RIM F FEC	US32D	HA
1 Passage Exit Trim(s)	45BE WLM	US26D	HA
1 Closer(s)	5100 HDCS	ALM	HA
1 Kick Plate(s)	190S 10" x 2" LDW	US32D	HA
1 Convex Wall Stop(s)	232W	US32D	HA
1 Seal	726 x LAR	S	HA
1 Door Position Switch(es)	2-679-0626		HA
1 Wiring Diagrams	Wiring Diagrams		

NOTE: Operational Description
Door monitored by access control system

Set #17

Doors: SA.2, SA.3

3 Hinge(s)	AB750 4 1/2" x 4 1/2" NRP	US26D	HA
1 Power Transfer(s)	2-679-0623	ALM	HA
1 Exit Device(s)	4501 RIM F RX FEC	US26D	HA
1 Electrified Trim(s)	45ET WLM	US26D	HA
1 Closer(s)	5100 HDCS	ALM	HA
1 Kick Plate(s)	190S 10" x 2" LDW	US32D	HA
1 Convex Wall Stop(s)	232W	US32D	HA
1 Seal	726 x LAR	S	HA
1 Door Position Switch(es)	2-679-0626		HA
1 Power Supply	2908/2909/2910/2911 As Required	No Finish	HA
1 Reader/Keypad	By Security Provider		
1 Wiring Diagrams	Wiring Diagrams		

NOTE: Operational Description
Door normally closed and locked
Entry by valid credential
Free egress at all times
Door unlocks upon power failure or fire alarm
Door is monitored by access control system

Set #18

Doors: C302A

6 Hinge(s)	AB750 4 1/2" x 4 1/2" NRP	US26D	HA
1 Power Transfer(s)	2-679-0623	ALM	HA
2 Exit Device(s)	4501 LBR FEC	US32D	HA
1 Electrified Trim(s)	45ET WLM	US26D	HA
1 Mortise Cylinder(s)	3902 SFIC	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
2 Closer(s)	5100 HD	ALM	HA
2 Kick Plate(s)	190S 10" x 1" LDW	US32D	HA
2 Convex Wall Stop(s)	232W	US32D	HA
2 Silencers	307D	GREY	HA
2 Door Position Switch(es)	2-679-0626		HA
1 Power Supply	2908/2909/2910/2911 As Required	No Finish	HA
1 Reader/Keypad	By Security Provider		
1 Wiring Diagrams	Wiring Diagrams		

Set #18

NOTE: Operational Description
Door normally closed and locked
Entry by valid credential
Free egress at all times
Door is unlocked upon power failure or alarm
Door is monitored by access control system

Set #19

Doors: C304

6 Hinge(s)	AB750 4 1/2" x 4 1/2" NRP	US26D	HA
1 Power Transfer(s)	2-679-0623	ALM	HA
1 Automatic Flush Bolt Set	292D	US32D	HA
1 Dust Proof Strike	280X	US26D	HA
1 Electrified Lockset	3880ELEU SECT WLM RX SFIC7	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Coordinator	297D x LAR	BLACK	HA
2 Mounting Bracket(s)	297M/297N (as required)	BLACK	HA
2 Closer(s)	5100 HD	ALM	HA
2 Kick Plate(s)	190S 10" x 1" LDW	US32D	HA
2 Convex Wall Stop(s)	232W	US32D	HA
2 Silencers	307D	GREY	HA
2 Door Position Switch(es)	2-679-0626		HA
1 Power Supply	2908/2909/2910/2911 As Required	No Finish	HA
1 Reader/Keypad	By Security Provider		
1 Wiring Diagrams	Wiring Diagrams		

NOTE: Operational Description
Door normally closed and locked
Entry by valid credential
Free egress at all times
Door remains locked upon power failure
Door is monitored by access control system

Set #20

Doors: 001A, C105A

3 Hinge(s)	AB750 4 1/2" x 4 1/2"	US26D	HA
1 Passage Set	3810 SECT WLM	US26D	HA
1 Closer(s)	5100	ALM	HA
1 Kick Plate(s)	190S 10" x 2" LDW	US32D	HA
1 Convex Wall Stop(s)	232W	US32D	HA
1 Seal	726 x LAR	S	HA

Set #21

Doors: 001B, 107C

3 Hinge(s)	AB750 4 1/2" x 4 1/2" NRP	US26D	HA
1 Storeroom Lockset	3880 SECT WLM SFIC7	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Closer(s)	5100 HDCS	ALM	HA
1 Kick Plate(s)	190S 10" x 2" LDW	US32D	HA
1 Seal	726 x LAR	S	HA

Set #22

Doors: 001

3 Hinge(s)	AB750 4 1/2" x 4 1/2"	US26D	HA
1 Passage Set	3810 SECT WLM	US26D	HA
1 Closer(s)	5100	ALM	HA
1 Kick Plate(s)	190S 10" x 2" LDW	US32D	HA
1 Seal	726 x LAR	S	HA
1 Door Position Switch(es)	2-679-0626		HA
1 Wiring Diagrams	Wiring Diagrams		

NOTE: Operational Description
Door monitored by access control system

Set #23

Doors: 109, 110, 113, 114, 228, 229, 236, 244, 246, 313, 316, 325, C303B, U204, U302, U306, U309

3 Hinge(s)	AB700 4 1/2" x 4 1/2"	US26D	HA
1 Passage Set	3810 SECT WLM	US26D	HA
1 Convex Wall Stop(s)	232W	US32D	HA
3 Silencers	307D	GREY	HA

Set #24

Doors: 252, 254, 256

3 Hinge(s)	AB750 4 1/2" x 4 1/2" NRP	US26D	HA
1 Office Lockset	3850 SECT WLM ADA Turn SFIC7	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Convex Wall Stop(s)	232W	US32D	HA
1 Coat Hook	956P 3 23/32	US26D	HA
3 Silencers	307D	GREY	HA

Set #25

Doors: U104, U107, U203

3 Hinge(s)	AB700 4 1/2" x 4 1/2" NRP	US26D	HA
1 Storeroom Lockset	3880 SECT WLM SFIC7	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Overhead Stop(s)	7016 SRF	US32D	HA
3 Silencers	307D	GREY	HA

Set #26

Doors: 117, 208B, U106

3 Hinge(s)	AB750 4 1/2" x 4 1/2"	US26D	HA
1 Classroom Lockset	3870 SECT WLM SFIC7	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Overhead Stop(s)	7016 SRF	US32D	HA
3 Silencers	307D	GREY	HA

Set #27

Doors: 105, 106, 112, 203, 211, 212, 238, 239, 311, 326, 327, 328D, 329D, 330C

Set #27

3 Hinge(s)	AB750 4 1/2" x 4 1/2"	US26D	HA
1 Privacy Set w/ Indicator	3896 SECT WLM ADA Turn	US26D	HA
1 Closer(s)	5100	ALM	HA
1 Kick Plate(s)	190S 10" x 2" LDW	US32D	HA
1 Convex Wall Stop(s)	232W	US32D	HA
3 Silencers	307D	GREY	HA

Set #27.1

Doors: 118, 202, 248, 324D

3 Hinge(s)	AB700 4 1/2" x 4 1/2"	US26D	HA
1 Privacy Set w/ Indicator	3896 SECT WLM ADA Turn	US26D	HA
1 Closer(s)	5100 HDCS	ALM	HA
1 Kick Plate(s)	190S 10" x 2" LDW	US32D	HA
3 Silencers	307D	GREY	HA

Set #28

Doors: C102

3 Hinge(s)	AB750 4 1/2" x 4 1/2" NRP	US26D	HA
1 Exit Device(s)	4501 RIM F FEC	US32D	HA
1 Classroom Exit Trim(s)	45CE WLM	US26D	HA
1 Mortise Cylinder(s)	3902 SFIC	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Closer(s)	5100 HD	ALM	HA
1 Kick Plate(s)	190S 10" x 2" LDW	US32D	HA
1 Convex Wall Stop(s)	232W	US32D	HA
1 Seal	726 x LAR	S	HA

Set #29

Doors: 207, 214, C104A, U105B

6 Hinge(s)	AB700 4 1/2" x 4 1/2" NRP	US26D	HA
1 Manual Flush Bolt Set	282D	US26D	HA
1 Dust Proof Strike	280X	US26D	HA
1 Storeroom Lockset	3880 SECT WLM SFIC7	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
2 Overhead Stop(s)	7016 SRF	US32D	HA
2 Kick Plate(s)	190S 10" x 1" LDW	US32D	HA
2 Silencers	307D	GREY	HA

Set #30

Doors: 119, 330D

3 Hinge(s)	AB700 4 1/2" x 4 1/2"	US26D	HA
1 Office Lockset	3850 SECT WLM ADA Turn SFIC7	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Overhead Stop(s)	7016 SRF	US32D	HA
1 Coat Hook	956P 3 23/32	US26D	HA
3 Silencers	307D	GREY	HA

Set #31

Doors: U105A

3 Hinge(s)	AB750 5" x 4 1/2"	US26D	HA
1 Storeroom Lockset	3880 SECT WLM SFIC7	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Closer(s)	5100 PSSA	ALM	HA
1 Kick Plate(s)	190S 10" x 2" LDW	US32D	HA
1 Seal	726 x LAR	S	HA

Set #32

Doors: 305A, 324, 328, 329, 330, U303

3 Hinge(s)	AB750 4 1/2" x 4 1/2"	US26D	HA
1 Classroom Lockset	3870 SECT WLM SFIC7	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Closer(s)	5100	ALM	HA
1 Kick Plate(s)	190S 10" x 2" LDW	US32D	HA
1 Convex Wall Stop(s)	232W	US32D	HA
3 Silencers	307D	GREY	HA

Set #33

Doors: 205

3 Hinge(s)	AB750 4 1/2" x 4 1/2"	US26D	HA
1 Pull Plate(s)	34J 4" x 16"	US32D	HA
1 Push Plate(s)	30S 8" x 16"	US32D	HA
1 Closer(s)	5100 HDCS	ALM	HA
1 Kick Plate(s)	190S 10" x 2" LDW	US32D	HA
3 Silencers	307D	GREY	HA

Set #34

Doors: 204, 206A, 206B, 301, 302

3 Hinge(s)	AB750 4 1/2" x 4 1/2"	US26D	HA
1 Pull Plate(s)	34J 4" x 16"	US32D	HA
1 Push Plate(s)	30S 8" x 16"	US32D	HA
1 Closer(s)	5100 HD	ALM	HA
1 Kick Plate(s)	190S 10" x 2" LDW	US32D	HA
1 Convex Wall Stop(s)	232W	US32D	HA
3 Silencers	307D	GREY	HA

Set #35

Doors: 210C, C201D

Set #35

3 Hinge(s)	AB750 4 1/2" x 4 1/2" NRP	US26D	HA
1 Exit Device(s)	4501 RIM FEC	US32D	HA
1 Classroom Exit Trim(s)	45CE WLM	US26D	HA
1 Mortise Cylinder(s)	3902 SFIC	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Closer(s)	5100 HD	ALM	HA
1 Kick Plate(s)	190S 10" x 2" LDW	US32D	HA
1 Convex Wall Stop(s)	232W	US32D	HA
3 Silencers	307D	GREY	HA

Set #36

Doors: 210A, 210B

8 Hinge(s)	AB750 4 1/2" x 4 1/2" NRP	US26D	HA
2 Exit Device(s)	4501 LBR FEC	US32D	HA
1 Classroom Exit Trim(s)	45CE WLM	US26D	HA
1 Mortise Cylinder(s)	3902 SFIC	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
2 Closer(s)	5100 HDCS	ALM	HA
2 Kick Plate(s)	190S 10" x 1" LDW	US32D	HA
2 Silencers	307D	GREY	HA

Set #37

Doors: 230A, U201, U202A, U206, U213

3 Hinge(s)	AB700 4 1/2" x 4 1/2" NRP	US26D	HA
1 Storeroom Lockset	3880 SECT WLM SFIC7	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Convex Wall Stop(s)	232W	US32D	HA
3 Silencers	307D	GREY	HA

Set #38

Doors: U210, U307, U311

6 Hinge(s)	AB750 4 1/2" x 4 1/2"	US26D	HA
2 Single Dummy	3817 SECT WLM	US26D	HA
2 Roller Latch(es)	318D	US26D	HA
2 Convex Wall Stop(s)	232W	US32D	HA
2 Silencers	307D	GREY	HA

Set #39

Doors: C202A

8 Hinge(s)	AB750 4 1/2" x 4 1/2" NRP	US26D	HA
2 Push Plate(s)	30S 8" x 16"	US32D	HA
2 Kick Plate(s)	190S 10" x 1" LDW	US32D	HA
2 Convex Wall Stop(s)	232W	US32D	HA
2 Silencers	307D	GREY	HA
2 Closer(s)	5100 HD	ALM	HA

Set #40

Doors: 304, U301, U310

3 Hinge(s)	AB700 4 1/2" x 4 1/2"	US26D	HA
1 Storeroom Lockset	3880 SECT WLM SFIC7	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Convex Wall Stop(s)	232W	US32D	HA
3 Silencers	307D	GREY	HA

Set #41

Doors: C304C

3 Hinge(s)	AB750 4 1/2" x 4 1/2" NRP	US26D	HA
1 Classroom Lockset	3870 SECT WLM SFIC7	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Closer(s)	5100 HD	ALM	HA
1 Kick Plate(s)	190S 10" x 2" LDW	US32D	HA
1 Convex Wall Stop(s)	232W	US32D	HA
3 Silencers	307D	GREY	HA

Set #42

Doors: SA.4

3 Hinge(s)	AB750 4 1/2" x 4 1/2" NRP	US26D	HA
1 Storeroom Lockset	3880 SECT WLM SFIC7	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Closer(s)	5100 HD	ALM	HA
1 Kick Plate(s)	190S 10" x 2" LDW	US32D	HA
1 Convex Wall Stop(s)	232W	US32D	HA
3 Silencers	307D	GREY	HA

Set #43

Doors: X208A

4 Hinge(s)	AB750 5" x 4 1/2"	US26D	HA
1 Passage Set	3810 SECT WLM	US26D	HA
1 Convex Wall Stop(s)	232W	US32D	HA
3 Silencers	307D/308D as req'd	GREY	HA

Set #44

Doors: XU202B

4 Hinge(s)	AB700 5" x 4 1/2"	US26D	HA
1 Storeroom Lockset	3880 SECT WLM SFIC7	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
2 Convex Wall Stop(s)	232W	US32D	HA
2 Silencers	307D/308D as req'd	GREY	HA

Set #45

Doors: 253A, X253B, X257B

Set #45

4 Hinge(s)	AB700 5" x 4 1/2"	US26D	HA
1 Office Lockset	3850 SECT WLM ADA Turn SFIC7	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Convex Wall Stop(s)	232W	US32D	HA
1 Coat Hook	956P 3 23/32	US26D	HA
3 Silencers	307D/308D as req'd	GREY	HA

Set #46

Doors: X250, X334

8 Hinge(s)	AB700 4 1/2" x 4 1/2"	US26D	HA
1 Manual Flush Bolt Set	282D 30" Top Rod	US26D	HA
1 Dust Proof Strike	280X	US26D	HA
1 Office Lockset	3850 SECT WLM ADA Turn SFIC7	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
2 Convex Wall Stop(s)	232W	US32D	HA
2 Silencers	307D/308D as req'd	GREY	HA

Set #47

Doors: 251A, XC205

4 Hinge(s)	AB750 4 1/2" x 4 1/2"	US26D	HA
1 Classroom Lockset	3870 SECT WLM SFIC7	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Overhead Stop(s)	7016 SRF	US32D	HA
3 Silencers	307D/308D as req'd	GREY	HA

Set #48

Doors: X335A, X336A, X338, X339

4 Hinge(s)	AB700 5" x 4 1/2"	US26D	HA
1 Passage Set	3810 SECT WLM	US26D	HA
1 Convex Wall Stop(s)	232W	US32D	HA
3 Silencers	307D/308D as req'd	GREY	HA

Set #49

Doors: X336B

4 Hinge(s)	AB750 5" x 4 1/2" NRP	US26D	HA
1 Exit Device(s)	4501 RIM FEC	US32D	HA
1 Classroom Exit Trim(s)	45CE WLM	US26D	HA
1 Mortise Cylinder(s)	3902 SFIC	US26D	HA
1 Construction Core(s)	3982-BLU	BLU	HA
1 Core(s)	Interchangeable Core	626	BE
1 Closer(s)	5100 HD	ALM	HA
1 Kick Plate(s)	190S 10" x 2" LDW	US32D	HA
1 Convex Wall Stop(s)	232W	US32D	HA
3 Silencers	307D/308D as req'd	GREY	HA

Set #50

Doors: 111, 115, 215, 216, 217, 218, 219, 220, 221, 222, 224, 225, 226, 227, 230, 231, 232, 232A, 235, 240, 241, 242, 243, 245, 247, 249, 255, 305B, 305C, 305D, 308, 309, 310, 315, 317, 318, 319, 320, 321, 322, 323, 324A, 324B, 324C, 328A, 328B, 328C, 329A, 329B, 329C, 330A, 330B, 330E, 332A, 332B, 333B				
3 Hinge(s)	AB700 4 1/2" x 4 1/2"	US26D	HA	
1 Office Lockset	3850 SECT WLM ADA Turn SFIC7	US26D	HA	
1 Construction Core(s)	3982-BLU	BLU	HA	
1 Core(s)	Interchangeable Core	626	BE	
1 Convex Wall Stop(s)	232W	US32D	HA	
1 Coat Hook	956P 3 23/32	US26D	HA	
3 Silencers	307D	GREY	HA	

Set #51

Doors: 121				
3 Hinge(s)	AB700 4 1/2" x 4 1/2"	US26D	HA	
1 Privacy Set w/ Indicator	3896 SECT WLM ADA Turn	US26D	HA	
1 Closer(s)	5100 HDCS	ALM	HA	
1 Kick Plate(s)	190S 10" x 2" LDW	US32D	HA	
1 Convex Wall Stop(s)	232W	US32D	HA	
3 Silencers	307D	GREY	HA	

END OF SECTION

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SECTION 08 80 10
EXTERIOR GLASS AND GLAZING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Exterior glass for storefront, curtain wall, aluminum entrances, and glass for vestibules and inner vestibule doors.
2. Glazing sealants and accessories.

B. Related Requirements:

1. Section 01 83 16 "Exterior Enclosure General Requirements" for additional requirements related to the building enclosure including but not limited to:
 - a. Performance and design requirements for the exterior building enclosure.
 - b. Coordination of Work required to complete the Exterior Enclosure.
 - c. Quality Assurance and Control procedures required for the work of the Exterior Enclosure.
 - d. Exterior Enclosure Mock-ups including Pre-Construction Mock-ups.
 - e. Independent inspection and testing required to verify performance of the work of this section.
2. Section 08 42 13 "Aluminum Framed Entrances"
3. Section 08 43 13 "Aluminum Storefront"
4. Section 08 44 13 "Glazed Aluminum Curtain Wall".
5. Section 08 80 05 "Interior Glazing"

1.2 DEFINITIONS

- A. Refer to Division 01 Section 01 83 16 "Exterior Enclosure General Requirements" for definitions related to Exterior Enclosure.
- B. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
- C. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

- D. Glazed Assembly: The glass and glazing materials specified herein and the framing system specified elsewhere, complete and compliant with requirements of both sections.
- E. Interspace: Space between lites of an insulating-glass unit.
- F. Defective Glass: Defects that are attributed to manufacturing process, fabrication or installation methods. Defects include (non-inclusive);
 - 1. Flatness and other dimensional tolerances, distortion, tong marks, roller wave, bulls eyes, edge chips, cracks, color consistency, incomplete edge deletion and other visible defects beyond those allowed by requirements included herein or by reference standard, whichever is more stringent.
 - 2. Deterioration described under warranty requirements.
 - 3. Out of tolerance fabrication.
 - 4. Spontaneous Breakage.
- G. Failed IGU: From SIGMA TB-1205-89 "Failed IG Units: an installed unit failure exhibits permanent material obstruction of vision through the unit due to accumulation of dust, moisture or film on the internal surface of the glass. Surface numbers 2 or 3 in dual-pane; surface 2, 3, 4 or 5 on triple-panes." In addition to the above definition, the following constitutes failure:
 - 1. Fogging or condensation on interior surfaces of IGU at any time.
 - 2. Visual distortion beyond specified tolerances.
 - 3. Change of appearance of the IGU spacer bond line.
 - 4. Running or sagging of edge sealants.
 - 5. Dislocation of edge spacer.
 - 6. Collapsed Glass Syndrome.
 - 7. Any other defect that reduces the clarity, appearance or performance of the glass.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate work of this section with adjacent components of the exterior enclosure. Participate in coordination required in Division 01 Section 01 83 16 "Exterior Enclosure General Requirements".
 - 1. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.
- B. Preinstallation Meetings:
 - 1. Preinstallation Conference: Conduct conference at Project site.
 - 2. In addition to requirements specified in Division 01 Section 01 31 00 "Project Management and Coordination," include the following:

- C. Exterior Enclosure Coordination Workshops: Participate in workshops indicated in Division 01 Section 01 43 25 "Exterior Enclosure Performance Requirements."
- D. Sequencing / Scheduling: Comply with requirements specified in Division 1 Section 01 43 25 "Exterior Enclosure Performance Requirements".

1.4 SUBMITTALS REQUIREMENTS

- A. Submit per the requirements of Section 01 33 00 Submittal Procedures and as indicated herein.
- B. CM shall coordinate submittals as indicated in 01 83 16 Paragraph 1.03-C and as otherwise indicated.
- C. Coordinate with submittals for 08 42 13, 08 42 29, 08 43 13, and 08 44 13.
- D. Submit the following in a single complete package, Partial submittal packages shall be rejected without action.
 - 1. Product data
 - 2. Glass Samples
 - 3. Glazing Accessory Samples
 - 4. Glazing Schedule
 - 5. Delegated design submittal.
 - 6. Qualification data
 - 7. Product certificates.
 - 8. Product test reports
 - 9. IGU Fabricators Certificate
 - 10. Preconstruction Adhesion and compatibility Test Report
 - 11. Sample Warranties

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product, sealant, spacer, desiccant, coating, and accessory required for glass and IGU.
- B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches square. Submit samples demonstrating the full range of variation of any item of glass, glazing accessory, sealant or gasket which may demonstrate variation in color, texture, and finish (including variations in color of IGU edge spacers) whether listed herein or not. Submission of single samples indicates that manufacturer represents no variation in color, texture and finish
- C. IGU Control Sample: For each type of IGU submit three control samples representing fabrication tolerances and variation in color, tolerances, glass defects, edge deletion, spacer location, and all other indicated criteria.

1. Control Sample shall include IGCC Certificate Label
 2. Sample shall be heat strengthened or fully tempered as indicated for the glass type.
 3. Ship control samples to project site.
 4. Control samples shall match most typical size required for project.
 5. After review and approval, return one control sample to IGU fabricator for use in their quality program and one control sample to curtain wall fabricator for use in their quality program and retain one sample on site.
 6. IGU Control samples may be incorporated into the final work if their location is recorded and the control samples are clearly identified for the duration of the project until Substantial Completion.
 7. Any IGU Control samples not incorporated into the final work will be turned over to Owner as part of indicated attic stock.
 8. IGU Control sample shall be used to establish baseline for color consistency of glass and coatings.
- D. Assembly Samples: Provide glazing for Assembly Samples indicated for curtain wall and other framing assemblies.
- E. Glazing Accessory Samples: For sealants and colored spacers, in 12-inch lengths.
- F. Glazing Schedule:
1. List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings. If additional types are required use a sub-designation number corresponding to designation indicated on Drawings.
 2. The Schedule shall include all glass required for the project regardless of sub-contractor furnishing glass.
 3. For IGU the schedule shall identify product and manufacturer for glass, edge spacer, edge spacer, construction components, connectors, fabrication techniques, internal components (if any) desiccant, gas filling, and accessories. Indicated IGCC Certification number.
 4. For laminated glass indicate glass types, thicknesses, with product and manufacturer of interlayer.
- G. 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.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, manufacturers of insulating-glass units, glass testing agency and sealant testing agency.
1. Certification Letter: Submit letter on primary glass manufacturer's letterhead indicating IGU fabricator complies with manufacturer's quality program.
- B. Product Certificates: For glass.

- C. IGU Fabricators Certificate. Provide data showing that each component listed in the IGCC Certificate is the same product intended to be used in this project.
 - 1. Provide a copy of the IGCC/IGMA and IGMAC LIST of REVIEWED SPACERS and INTEGRATED SPACER SYSTEMS with the exact spacer intended for this project highlighted.
 - 2. Provide a copy of the IGCC/IGMA and IGMAC LIST OF REVIEWED DESICCANTS with the exact dessicant intended for this project highlighted.
 - 3. Provide a copy of the IGCC/IGMA and IGMAC LIST OF REVIEWED SEALANTS with the exact sealant intended for this project highlighted.
 - 4. Indicate fabrication plant matches plant shown on certification.
- D. Product Test Reports: For tinted glass, coated glass, insulating glass and glazing sealants, for tests performed by a qualified testing agency.
 - 1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.
- E. Preconstruction adhesion and compatibility test report.
- F. Sample Warranties: For special warranties.

1.7 QUALITY ASSURANCE

- A. Primary Glass Manufacturer Qualifications: Manufacturer shall have produced glass within tolerances, color consistency and other criteria indicated for this project on three previous projects of similar scope and complexity.
- B. IGU Fabricator Qualifications: IGCC Certified for the IGU specified for this project.
- C. Fabricator Qualifications: Company who is trained and approved for fabrication of laminated, coated, insulated or other glass required for this Project.
 - 1. Experience: Minimum five (5) years fabricating glazing similar to that required for this Project.
 - 2. Completed three (3) projects of scope, schedule and complexity similar to this Project using systems similar to those required for this Project within last two (2) years as acceptable to Architect.
 - 3. Adequately trained by primary glass manufacturers for type of fabrication required for this Project.
 - 4. Glass with Sputter-Coated Low-E Coating: qualified by coated-glass manufacturer
 - 5. Glass for Toggle-glazing: Qualified by curtain wall manufacturer.
 - 6. IGU Fabricator Certification: IGU fabricator shall certify that all the products required for the IGU proposed on this project have been used successfully together in the past.

- D. Installer Qualifications: Company who is trained and experienced to install glass required for this Project.
1. Experience: Minimum five (5) years installing glazing similar to that required for this Project.
 2. Completed three (3) projects of scope, schedule and complexity similar to this Project using systems similar to those required for this Project within last two (2) years as acceptable to Architect.
 3. Adequately trained by primary glass manufacturers for type of installation required for this Project.
 4. Coordinate with qualifications indicated in other Division 08 sections for the fenestration systems into which the glass is installed.
- E. Delegated Design Engineer: Professional Engineer, licensed in State of Delaware and having a minimum of five (5) years documented experience engineering glass and glazing similar to that required for this Project.
- F. Glazing Sealant Manufacturer's Technical Representative Services: An authorized and approved technical representative of the joint sealant manufacturer shall visit the project site, evaluate the existing substrates and sealants and make recommendations for the best sealant within their product line for the conditions present.
1. Include recommendations for sealant.
 2. Include recommendations for backing and accessories.
 3. Include recommendation for primer or if no primer is required.
- G. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.
- H. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

1.8 PRECONSTRUCTION TESTING

- A. Preconstruction Adhesion and Compatibility Testing: Test each glass product, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.
1. Testing is not required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.
 2. Use ASTM 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.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Do not handle, ship or otherwise disturb fabricated glazing such as insulated glazing units until seals and sealants or similar materials have adequately cured as recommended by manufacturer.
- B. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
- C. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.
- D. Ship and store under conditions which will not have a deleterious effect on the finished work.
- E. Attach sticker, tag or other identification to each panel as identified on shop drawings. Identify exterior side of glass.

1.10 FIELD CONDITIONS

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

1.11 WARRANTY

- A. Refer to Sections 08 42 13, 08 43 13, and 08 44 13 for warranty requirements for installed warranted glass.
- B. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.

1. Warranty Period: 10 years from date of Substantial Completion.
- C. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
1. Warranty Period: 10 years from date of Substantial Completion.
- D. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal, fogging of the unit, any change of appearance of the unit, degradation of the primary and secondary seals, and/or degradation of the dessicant, which may occur under normal use that is not attributable to glass breakage (except spontaneous breakage of fully tempered glass) or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Failure is further defined to include IGU with individual glass layers that fail or deteriorate as described for warranty herein. Evidence of failure includes but is not limited to the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
1. Warranty Period: 10 years from date of Substantial Completion.
- E. Manufacturer's Special Warranty for Fully Tempered Glass: In addition to other warranty coverage, manufacturer agrees to replace fully tempered glass units, including FT units used in IG, that crack or experience spontaneous breakage within specified warranty period. Fully tempered glass that breaks from observed impact is not included in warranty.
1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design glazing for structural and thermal performance.

- C. Comply with performance criteria indicated in Section 01 83 16 "Exterior Enclosure General Requirements" and additional criteria indicated herein.
- D. Thermal Performance: Analyze and select glass and glass coatings in coordination with the window wall, curtain wall and entrance framing to provide the system u-factors and SHGC indicated for those framing systems.
- E. Structural Performance: Design and select glass, including comprehensive engineering analysis to withstand the following design loads within limits and under conditions indicated determined according to the IBC and ASTM E 1300.
 - 1. Probability of Breakage for Sloped Glazing: For glass surfaces sloped more than 15 degrees from vertical, design glass for a probability of breakage not greater than 0.001.
 - 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.
 - 3. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.
 - 4. Design Wind Pressures:
 - a. Cladding and Component loads as Specified in Section 01 83 16 and as indicated on S-001.
 - b. Vertical Glazing: For glass surfaces sloped 15 degrees or less from vertical, design glass to resist design wind pressure based on glass type factors for short-duration load.
 - c. Sloped Glazing: For glass surfaces sloped more than 15 degrees from vertical, design glass to resist each of the following combinations of loads:
 - 1) Outward design wind pressure minus the weight of the glass. Base design on glass type factors for short-duration load.
 - 2) Inward design wind pressure plus the weight of the glass plus half of the design snow load. Base design on glass type factors for short-duration load.
 - 3) Half of the inward design wind pressure plus the weight of the glass plus the design snow load. Base design on glass type factors for long-duration load.
 - 5. Glass Type Factors for Wired, Patterned, and Sandblasted Glass:
 - a. Short-Duration Glass Type Factor for Patterned Glass: 1.0.
 - b. Long-Duration Glass Type Factor for Patterned Glass: 0.6.
 - c. Short-Duration Glass Type Factor for Sandblasted or Acid Etched Glass: 0.5.
 - 6. Glass Thicknesses: In order to provide color and optical uniformity any type of glass shall have the same thickness throughout the Project, including glass used to make up insulating units.

- a. Base thickness on largest light, highest loading or a combination thereof to determine thickness for that particular type of glass for the entire Project.
 - b. Thickness: Provide glass lites in thicknesses as needed to comply with requirements indicated.
 - c. Minimum Glass Thickness: Not less than 6.0 mm.
7. Strength:
 - a. Where float glass is indicated, provide annealed float glass, or Kind HS heat-treated float glass as needed to comply with "Performance Requirements" Article.
 - b. Where heat-strengthened glass is indicated, provide Kind HS heat-treated float glass as needed to comply with "Performance Requirements" Article. Increase thickness if necessary to carry load. Do not change to Kind FT.
 - c. Provide Kind FT fully-tempered heat-treated float glass only where indicated, otherwise do not use Kind FT. Kind FT glass will not be allowed in any overhead location.
8. Probability of Breakage for Sloped Glazing: For glass surfaces sloped more than 15 degrees from vertical, design glass for a probability of breakage not greater than 0.001.
9. 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.
10. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.
11. Thermal and Structural Movements: Allow for movement of structural and for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components. Comply with requirements of Division 01 Section 01 43 25 "Exterior Enclosure Performance Requirements" in addition to those specified herein.
12. Structural Silicone Glazing: Comply with the following:
 - a. IGU: Design width of spacer to accommodate thermal and mechanical movement and required loading.
 - b. Glazing to Glazing Joints: Designed to accommodate thermal and mechanical movement, prevent glazing contact with adjacent materials or other glazing, and maintain required edge clearances.
 - c. Isolation: Thermally and physically isolate glazing from metal framing.
 - d. Tensile and Shear Stresses in Silicone Joints: Maximum design stress of 20 psig.
 - e. Gravity Loads: Structural silicone shall not carry gravity load of glazing.
 - f. Adhesion: Sealant shall fail cohesively before failure to adhere to substrate when tested with each substrate and joint condition.
 - 1) Adhesion failure occurs when sealant pulls away from substrate cleanly leaving little or no sealant material behind.
 - 2) Cohesion failure occurs when sealant breaks or tears within sealant but remains bonded to substrates.

- F. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
1. GANA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."
 2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- G. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II or ANSI Z-97.1-Class A as suited for application.
- H. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
1. For monolithic-glass lites, properties are based on units with lites 6 mm thick.
 2. For laminated-glass lites, properties are based on products of construction indicated.
 3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
 4. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F.
 5. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
 6. Visible Reflectance: Center-of-glazing values, according to NFRC 300.
- I. Color consistency: Monolithic glass, coated glass and insulating glass units color consistency shall comply with ASTM C 1376 except more stringent requirements noted.
1. The ΔE_{ab} color readings variation shall not exceed 2.0 for any reading. The color target shall be determined by averaged readings from approved control samples, not by an average of all readings.
 2. Glass units shall also comply with the ΔH measurement defined by ASTM D2244. The color target shall be determined by averaged readings from approved control samples, not by an average of all readings. Readings across each lite of glass shall not exceed ± 1.0 and shall not vary more than $\Delta 1.5$ from the color target."

2.2 MANUFACTURERS

- A. Basis-of-Design Glass Product: Subject to compliance with requirements, provide primary products for IGU indicated in glass schedules or comparable product by one of the following:

1. Pilkington North America Inc.
2. Vitro Architectural Glass/PPG Industries, Inc.
3. Oldcastle
4. Saint-Gobain Corporation.
5. Guardian Glass

B. Source Limitations for Glass:

1. Obtain from single source from single manufacturer for each type of un-coated or coated glass required for the project.
2. Obtain from single source from single manufacturer for each type of coating applied to glass.
3. Obtain from single source from single manufacturer each type of laminated glass interlayer required for the project.
4. Obtain from single source from single supplier for each type of glazing sealant, gasket and glazing accessory required for the project.
5. Obtain from single source from single manufacturer for each type of IGU required for the project.

C. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

2.3 GLASS PRODUCTS, GENERAL

- A. 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.
- B. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC that will be visible in the finished work.
- C. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.
1. Minimum Glass Thickness for Exterior Lites: 6 mm.
 2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.
- D. Strength: Where annealed float glass is indicated, provide annealed float glass or heat-strengthened float glass, as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass as needed to comply with "Performance Requirements" Article. Do not use fully tempered float glass except where indicated.

2.4 GLASS PRODUCTS

- A. Clear Annealed Float Glass: ASTM C 1036, Type I, Class 1 (clear), Quality-Q3.
- B. 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. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
 - 2. Heat Soaking: Heat soak 100% of fully tempered glass in accordance with EN 14179 and with a minimum 2 hour dwell time.
- C. Heat-Strengthened Float Glass: ASTM C 1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
 - 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
- D. Ceramic-Coated Spandrel Glass: ASTM C 1048, Type I, Condition B, Quality-Q3.

2.5 INSULATING GLASS

- A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190. IGU shall be IGCC/IGMA certified. for seal durability of insulating glass units and passing gas content initial and after weathering (GCIA) certification requirements. All components shall be as required for the IGCC Certificate.
 - 1. Sealing System: Dual seal, with polyisobutylene primary and silicone secondary sealants.
 - a. Color: Black.
 - 2. Spacer: Stainless steel, black.
 - 3. Desiccant: A blend of both molecular sieve and silica gel selected to adsorb water vapor and to absorb hydrocarbons and other volatile species (organic vapor) to protect the IG unit against chemical fogging and against staining coated glass due to volatile off-gassing
 - 4. Interspace Content:
 - a. Base Price: Air
 - b. Add Alternate: 10% Air, 90% Argon.

2.6 GLAZING SEALANTS

- A. Manufacturer and Products: Subject to compliance with requirements, provide products of the following manufacturers as recommended by manufacturer's technical representative based on substrates, indicated criteria and testing. Manufacturer's technical representative shall select the most appropriate sealant and primer combination for the project specific application and substrates from manufacturer's full line. Comply with requirements of Section 07 92 10 "Exterior Joint Sealants".
1. Silicone Joint Sealant Manufacturers:
 - a. Dow
 - b. Tremco Incorporated.
 - c. GE Silicones
- B. General:
1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
 3. Field-applied sealants shall have a VOC content of not more than 250 g/L.
 4. Colors of Exposed Glazing Sealants: Black except Gray at SSG.
- C. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Minimum Class 50, Use NT.

2.7 GLAZING GASKETS AND TAPES

- A. Glazing Gaskets: Silicone sealed-corner pressure-glazing system of, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.
1. Color: black.
- B. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
- C. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:

1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
 2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.
- D. Color: Black for all glazing tapes, gaskets and accessories exposed to view.

2.8 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, with requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Primers and Sealers applied with the building interior: VOC content not to exceed 200g/L.
- C. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- D. Setting Blocks: Silicone, Shore, Type A durometer hardness of 85, plus or minus 5.
- E. Spacers: Silicone blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- F. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
- G. 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.
- H. Backpans, non-glass vision panels and other metal components are specified in the window wall, curtain wall or other assembly framing section.

2.9 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
- B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.
- C. Grind smooth and polish exposed glass edges and corners.

- D. Roller Wave Distortion: Parallel to bottom edge of glass as installed.
- E. Opacify inside surfaces of glass which would otherwise allow light into areas not meant to be exposed to view in the finished work. Use opaque ceramic coating or apply continuous silicone coating in color selected by architect.
 - 1. For glass that is indicated to be opaque and is indicated to be installed without an additional back-up material, the glass shall be opaque when viewed from 3 feet with normal daylight on both sides of the sample.
- F. Laminated glass units shall be fabricated to tolerances indicated in ASTM C 1172 and as follows:
 - 1. Fabricate primary glass layers and interlayers to tolerances necessary to provide final laminated unit of the tolerances indicated.
 - 2. Roller Wave Distortion: Parallel to bottom edge of glass as installed.
 - 3. Edge alignment:
 - a. Viewing distance 3 feet or less: Edges shall not be offset by more than 1/16" between individual lights.
 - b. Viewing distance from 10 feet to 3 feet: Edges shall not be offset by more than 3/32".
 - c. Viewing distance from over 10 feet: Edges shall not be offset by more than 1/8".
 - 4. Alignment of holes: As required for proper function of the bolt, clamp or bracket to be mounted through the hole but not more than 1/8".
- G. Insulating Glazing Units (IGU) Fabrication: Fabricate IGU to comply with indicated requirements.
 - 1. IGU fabricator shall certify that they have tested all possible products used to cut, lubricate, clean, fabricate, handle, store, or process glass are compatible with glass, glass coatings, primary seal and secondary seal.
 - 2. Provide IGCC label that will be visible in the finished work.
 - 3. Target width of primary seal shall be minimum of 5/32".
 - 4. Minimum thickness of secondary seal shall be 1/16".
 - 5. There shall be no skips in the primary seal.
 - 6. Roller Wave Distortion: Parallel to bottom edge of glass as installed.
 - 7. At units for SSG, flat-grind edges to produce square edges with slight chamfers at junctions of edges and faces.
 - 8. Edge delete all coated glass products except for ceramic frit coated glass, to provide a clean pure glass surface for adhesion of spacers.
 - a. Comply with coating manufacturer's written instructions for methods of edge deletion. Edge delete to comply with requirements herein even if not required by coating manufacturer, primary glass manufacturer, sealant manufacturer or IGU fabricator.

- b. Edge deletion shall remove 100% of coatings and extend to raw glass surface. Eliminate any residual coating resulting in reduced or potentially reduced bonding or variation in color, texture or reflection at bonded surface.
 - c. Edge delete shall extend to a line between 50% and 100% of the width of the idealized path of the primary sealant.
 - d. At offset IGUs, edge delete the entire offset surface area.
 - e. Test for deletion of Low- E coating and similar metallic conductive coating with ohm-meter and test visually. Visually compare edge deleted glass to a piece of clear glass of the same thickness against a white background. No color difference should be detectable.
 - f. Where edge deletion is of different widths, provide stickers on glass indicating proper orientation and location of edge deletion.
 - g. Inspect and clean prior to further fabrication.
9. IG Unit Seal/Sealant and Desiccant Testing:
- a. Butterfly unit adhesion pull test (from 12"x12" to 24"x24"), test every shift or carton change.
 - b. Desiccant temperature rise test, test every shift or carton change.
 - c. Documentation recorded and available upon request
10. Seal all spacer connections.
11. Fill interspace with indicated gas and seal. Gas fill tubes shall be located in the top of the spacer.
12. Secondary seal shall be cleaned and tooled before packing with no smear of sealant on adjacent edges or surfaces. Clean residual spacer sealant from surface and edges of glass exposed to view.
13. For IGU fabricated at an altitude difference of 2000 feet or more from the project altitude, fabricate with breather devices to compensate for atmospheric pressure differential. Ship, store and handle to ensure that fill gases do not escape. Seal breather device at project site or fenestration fabrication plants within the 2000 feet altitude difference.
- H. Mark each lite of glass with stickers showing type of glass matching glass schedule, which surface is to be installed to exterior, top of lite, uniform pattern, draw, bow, and similar characteristics, locations of edges deleted or surfaces otherwise prepared for bonding.
- 1. Mark each individual lite uniquely to identify intended location for field installation or shop glazing to match shop drawings.
 - 2. Do not remove stickers until cleaning for Substantial Completion.

2.10 SOURCE QUALITY CONTROL

A. Fabrication Tolerances:

1. General: Fabricate glass to tolerances as required to:
 - a. Match approved Sample.
 - b. Match approved Mockups.
 - c. Comply with performance criteria.
 - d. Comply with requirements of ASTM C 1036 and C 1048 except where stricter tolerances are indicated.
 - e. Comply with manufacturer's written instructions.
 - f. Achieve tolerances indicated for Final Work.
 - g. Align with other supported or adjacent Work with more stringent tolerances.
 2. Fabricate to tolerances tighter than indicated for fabrication if necessary so that once installed the tolerances shall be within limits indicated for the completed work.
- B. Viewing Conditions: Visual inspections of glass and IGU for both coated and uncoated materials shall be made with 20/20 vision (naked eye or corrected) at a distance of 3 feet from the glass surface at any angle from any direction under natural lighting conditions. Measurements for dimensional tolerances shall be made at closer viewing conditions. For glass to be located more than 2 stories above a normally walkable surface, interior or exterior, the viewing distance shall be increased to 10 feet.
- C. Roller Wave Distortion of Heat-Treated Glass:
1. Tolerance for roller wave is maximum 0.003" from peak to valley in the center of lites, and a maximum of 0.008" within 10.5" of the leading or trailing edge when measured in accordance with ASTM C1651 Standard Test Method for Measurement of Roll Wave Optical Distortion in Heat-Treated Flat Glass
 2. Tolerance for Millidiopter: (90% Surface) Maximum + or – 120 A Overall
 - a. Localized Bow and Warp: Tolerance for localized bow and warp for rectangular glass is 1/32" over any 12" and ½ of values in ASTM C 1048.
 - b. Fabrication Tolerances for Insulating Glazing Units (IGUs): Fabricate to comply with approved submittals and samples and the following, whichever is more stringent.
 3. Definitions: Refer to Glass Informational Bulletin GANA ID 02-1011, Guidelines for the Appearance of Insulating Glass Unit Edges in Commercial Applications.
 4. Fabricate to comply with GANA ID 02-1011 as a minimum and the more stringent requirements included herein.
 5. Fabricate to comply with IGMA Publication for Insulating Glass: TB-1200-83 "IGMA Guidelines for Insulating Glass Dimensional Tolerances" as a minimum and the more stringent requirements included herein.
 6. Localized Bow and Warp of IGU Panes: Glass shall be free of bow and warp to limit visual distortion to not exceed aesthetic standards established with samples and mockups. In no case shall the tolerance for localized bow and warp shall not exceed the lesser of the following:
 - a. 1/32" over any 12"

- b. $\frac{1}{2}$ of values in ASTM C 1048
 - c. Measured bow and warp in fabricated samples and in mockups.
7. Appearance Guidelines for Glass Edge Quality at Silicone Structural Glazed (SSG) IGU:
- a. Edge Criteria: Criteria for non-uniformities shall be one half of those allowed for each type of glass per the appropriate standards, including but not limited ASTM C 1036, C 1048, C 1172, and C 1376.
 - b. Color Variation of Secondary Sealant: Not visible from Viewing Conditions indicated.
 - c. Color difference Between Primary and Secondary Sealants: Not visible from Viewing Conditions indicated.
 - d. Separation between primary and secondary sealants: Not visible from Viewing Conditions.
 - e. Offset Lites: Cover the offset glass edges.
 - f. Minimum Sightline Dimension at SSG: The minimum sightline width for a contiguous area of adjacent IGU shall be the maximum width required for structural performance as determined by Delegated Design Engineer.
 - g. Carbon Black: Carbon black discoloration in gray primary or secondary sealant shall not be visible from Viewing Conditions indicated.
 - h. Coated Glass Edge Deletion in Captured Lites: Not visible from Viewing Conditions indicated and confined to the captured area.
 - i. Spacers shall be parallel to edge of glass plus or minus 1/8 inch maximum from the glazed daylight opening with maximum variation of 1/8 inch in any 4 feet and shall not extend past outside edge of glass in any case.
 - j. Primary Sealant Infringement: Shall not exceed 1/8 inch beyond spacer.
 - k. Spacer and line of primary sealant shall not deviate by more than 1/8" in 36", not more than
8. IGU overall thickness at edge shall be minus 1/16" and plus 1/32".
- D. Independent Inspection and Testing: Comply with requirements of Division 1 Section 01 45 25 "Exterior Enclosure Inspection and Testing Services" for independent inspection and testing required to verify performance of the work of this section.
- E. Comply with requirements of Division 01 Section 01 43 25 "Exterior Enclosure Performance Requirements" for Quality Assurance and Control procedures required for the work of the Exterior Enclosure.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine glass and IGU.

1. Verify conformance with indicated requirements.
 2. Verify conformance with control sample.
 3. Verify location of low-e coatings using devices recommended by manufacturer and confirm that exterior surface is clearly and properly indicated.
 4. Verify IGCC Label is visible on IGU.
 5. Do not install non-conforming glass or IGU.
- B. 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.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

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

3.3 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.
- C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

- F. Provide spacers for glass lites where length plus width is larger than 50 inches.
 - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
 - 2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.
- J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
 - B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Do not remove release paper from tape until right before each glazing unit is installed.
- F. Apply heel bead of elastomeric sealant around full perimeter.

- 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.
- I. Use typically for hollow metal work.

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. Install gaskets so they protrude past face of glazing stops.
- E. Use typically for all aluminum storefront and entrance work, unless otherwise indicated.

3.6 PRESSURE PLATE 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. Apply heel bead of sealant along intersection of permanent stop with frame along the bottom mullion of each lite and extend vertically 6 inches to provide air and water tight seal to glazing.
- D. Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket and heel bead.
- E. 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.

- F. Install gaskets so they protrude past face of glazing stops.
- G. Use typically for all aluminum curtain wall work, unless otherwise indicated.

3.7 STRUCTURAL SILICONE GLAZING

- A. General: Comply with sealant manufacturer's written instructions.
- B. Shop Fabrication: Four-sided structural silicone glazing shall be completed in shop. Glass shall be glazed onto metal subframes for mechanical attachment in field.
- C. Preparation: Clean surface of substrate and glass by pouring solvent onto a clean rag, wiping vigorously and immediately wiping excess solvent away with a second clean rag.
- D. Priming: Prime surface of metal using a thin film adhesion promoter.
- E. Install spacer tape on metal frame. Install setting blocks. Apply structural silicone.
- F. Center lite in opening, rest on setting blocks and push glazing into sealant to provide continuous contact. Tool joint smooth and straight. Temporarily support glass until sealant sets up.
- G. Use at operable lights in curtain wall and where indicated.

3.8 CLEANING AND PROTECTION

- A. Immediately after installation remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
 - 1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.
- C. Remove and replace glass that is damaged during construction period.
- D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.9 ERECTION TOLERANCES

- A. Erection Tolerances: Install glazed aluminum curtain walls to comply with Division 01 Section "Exterior Enclosure Performance Requirements" and as required to:
 - 1. Comply with requirements of Section 01 83 16
 - 2. Match approved Samples and Mock-up.
 - 3. Comply with performance criteria.
 - 4. Comply with manufacturer's written instructions.
 - 5. Align with other supported or adjacent Work with more stringent tolerances.

3.10 FIELD QUALITY CONTROL

- A. Refer to Section 01 45 25-Exterior Enclosure Testing Services.
- B. Glazing methods shall not result in installed glass exceeding the tolerances indicated in Part 2 of this specification.

3.11 INSULATING GLASS SCHEDULE

- A. Final glass, coating types and number of coatings is dependent on final engineering to comply with thermal performance for complete glazed assembly. Coordinate with window wall, curtain wall, entrances and other framing systems for glazed assembly criteria.
- B. Indications for "Use/Location" in schedule are provided for convenience and does not limit the use of the scheduled glass from any location if indicated elsewhere.
- C. Safety Glass: Provide fully tempered glass where indicated on elevations A615 and A616.
- D. Glass Type G1: Clear, Low-E-coated, insulating glass.
 - 1. Typical Use/Location: Punched openings as indicated.
 - 2. Overall Unit Thickness: 1 inch.
 - 3. Outdoor Lite: Clear fully tempered float glass – 1/4".
 - 4. Interspace Content:
 - a. Base Price: Air
 - b. Add Alternate: 10% Air, 90% Argon.
 - 5. Indoor Lite: Clear, fully tempered float glass – 1/4".
 - 6. Low-E Coating: High performance, triple silver, sputtered coating on second surface, Basis of Design – SunGuard SNX 51/23 on clear by Guardian Glass
 - 7. Performance is based on the Basis of Design products in configurations listed. Alternate glass must meet or exceed performance of the indicated units.

- a. Visible Light Transmittance = minimum 50%
- b. Center-of-glass Winter U-Value = 0.240 maximum
- c. Summer Daytime U-Factor: = 0.210 maximum.
- d. Visible Light Reflectance - Exterior: 14 percent maximum.
- e. SHGC = 0.26 maximum.

E. Glass Type G2: Tinted, Low-E-coated, insulating glass.

1. Typical Use/Location: Punched openings as indicated.
2. Overall Unit Thickness: 1 inch.
3. Outdoor Lite: Gray fully tempered float glass – 1/4". Basis of Design Guardian Crystal Gray
4. Interspace Content:
 - a. Base Price: Air
 - b. Add Alternate: 10% Air, 90% Argon.
5. Indoor Lite: Clear, fully tempered float glass – 1/4".
6. Low-E Coating: High performance, triple silver, sputtered coating on second surface, Basis of Design – SunGuard SNX 51/23 on Crystal Gray by Guardian Glass
7. Performance is based on the Basis of Design products in configurations listed. Alternate glass must meet or exceed performance of the indicated units.
 - a. Visible Light Transmittance = minimum 35%
 - b. Center-of-glass Winter U-Value = 0.240 maximum
 - c. Summer Daytime U-Factor: = 0.210 maximum.
 - d. Visible Light Reflectance - Exterior: 10 percent maximum.
 - e. SHGC = 0.21 maximum.

F. Glass Type G3: Tinted, Low-E-coated, insulating glass.

1. Typical Use/Location: Punched openings as indicated.
2. Overall Unit Thickness: 1 inch.
3. Outdoor Lite: Gray fully tempered float glass – 1/4". Basis of Design Guardian Crystal Gray
4. Interspace Content:
 - a. Base Price: Air
 - b. Add Alternate: 10% Air, 90% Argon.
5. Indoor Lite: Clear, fully tempered float glass – 1/4".
6. Low-E Coating: High performance, triple silver, sputtered coating on second surface, Basis of Design – SunGuard SNR 43 on Crystal Gray by Guardian Glass
7. Performance is based on the Basis of Design products in configurations listed. Alternate glass must meet or exceed performance of the indicated units.

- a. Visible Light Transmittance = minimum 30%
 - b. Center-of-glass Winter U-Value = 0.240 maximum
 - c. Summer Daytime U-Factor: = 0.212 maximum.
 - d. Visible Light Reflectance - Exterior: 10 percent maximum.
 - e. SHGC = 0.18 maximum.
- G. Glass Type G4: Match GL-3.
- H. Glass Type G5: Match GL-3.
- I. Interior Glass: Refer to specification 08 80 00

END OF SECTION

SECTION 08 83 00

MIRRORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Annealed, unframed, monolithic film-backed glass mirrors.

1.2 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements:

1. Store mirrors inside building after it is fully enclosed.

1.3 FIELD CONDITIONS

A. Ambient Conditions: Perform work within following limitations.

1. Building enclosed and environmental systems maintaining design conditions for Owner occupancy.
2. Installation Temperature: Minimum 50 degrees F.

1.4 WARRANTY

A. Manufacturer Warranty: Manufacturer standard warranty.

1. Warrant against silver spoilage and delamination.
2. Warranty Period: 5 years.

PART 2 - PRODUCTS

2.1 MIRRORS

A. Back-Coated Safety Mirrors: ASTM C1036, Type 1 transparent flat, Quality- Q2 mirror; Class 1-Clear, with copper and silver coating, organic overcoating, and special back coating or film per CPSC 16 CFR 1201 Category II safety glazing standard.

1. Edges: Flat Polished.
2. Thickness: 6 mm.

2.2 INSTALLATION MATERIALS

- A. Mirror Clips: Polished chrome-plated steel with anchorage screws.
 - 1. Manufacturers:
 - a. C.R. Laurence.
 - b. Or approved equal.
- B. Mirror Mastic: Adhesive setting compound manufactured specifically for mounting mirrors, compatible with mirror backing materials and substrate.
 - 1. VOC Content: Maximum 70 g/L.

2.3 PERFORMANCE

- A. Impact:
 - 1. Safety Mirrors: Comply with 16 CFR 1201, Category II.

2.4 FABRICATION

- A. Fabricate mirrors for 1/8 inch clearance to adjacent construction.
- B. Seal edges to prevent chemical or atmospheric penetration of reflective coating.
- C. Film-Backed Safety Mirrors: After cutting to size, apply film backing to produce smooth surface without bubbles, wrinkles, and other imperfections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that wall surfaces are in plane so mirrors can be installed without distortion.

3.2 PREPARATION

- A. Clean surfaces that receive adhesive installation are free of contaminants that affect adhesion.

3.3 INSTALLATION

- A. Perform Work in accordance with GANA Glazing Manual for mirror installation methods.
- B. Provide safety mirrors for units with bottom edges within 36 inches of floor.
- C. Install mirrors plumb and level, and free of optical distortion.
- D. Install mirrors with minimum 1/8 inch clearance from other construction.

E. Frameless Mechanical Installation:

1. Install mirror clips maximum 24 inches on center at mirror edges not secured by channels.

F. Frameless Adhesive Installation:

1. Set mirrors so that adhesive mastic forms uniform anchorage thickness.
2. Hold mirrors in place until adhesive sets.

3.4 CLEANING

- A. Remove labels, wash and polish mirror surfaces and metal supports.

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SECTION 08 91 19

FIXED LOUVERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fixed, extruded-aluminum exterior architectural louvers.
2. Blank-off Panels within louvers.
3. Reinforcing and anchors for louvers.

B. Related Requirements:

1. Section 01 43 25 "Exterior Enclosure Performance Mockup".
2. Section 01 4525 "Exterior Enclosure Testing Services"
3. Section 01 83 16 "Exterior Enclosure General Requirements" for additional requirements related to the building enclosure including but not limited to:
 - a. Performance and design requirements for the exterior building enclosure.
 - b. Coordination of Work required to complete the Exterior Enclosure.
 - c. Quality Assurance and Control procedures required for the work of the Exterior Enclosure.

1.2 DEFINITIONS

- A. Definitions: Refer to Division 01 Section 01 83 16 "Exterior Enclosure General Requirements" for definitions related to Exterior Enclosure.
- B. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
- C. Horizontal Louver: Louver with horizontal blades (i.e., the axes of the blades are horizontal).
- D. Vertical Louver: Louver with vertical blades (i.e., the axes of the blades are vertical).
- E. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

- F. Wind-Driven-Rain-Resistant Louver: Louver that provides specified wind-driven rain performance, as determined by testing according to AMCA 500-L.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate work of this section with adjacent components of the exterior enclosure. Participate in coordination required in Division 01 Section 01 83 16 "Exterior Enclosure General Requirements".
- B. Preinstallation Meetings:
 - 1. Preinstallation Conference: Conduct conference at Project site.
 - 2. In addition to requirements specified in Division 01 Section 01 31 00 "Project Management and Coordination," include the following:
- C. Exterior Enclosure Coordination Workshops: Participate in workshops indicated in Division 01 Section 01 43 25 "Exterior Enclosure Performance Requirements."
- D. Sequencing / Scheduling: Comply with requirements specified in Division 1 Section 01 43 25 "Exterior Enclosure Performance Requirements".

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
- B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
 - 1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
 - 2. Show mullion profiles and locations.
 - 3. Show insulated panels
 - 4. Show interface with ductwork.
- C. Samples: For each type of metal finish required.
- D. Coated Metal Coordinated Color Samples: For each exposed finish required submit two samples for the Coated Metal Coordinated Color Samples specified in Section 01 83 16. After approval, one sample will be returned.
 - 1. Samples shall an actual sample coated from the same coating line and in the exact same manner as will be utilized for the actual work.

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2. Provide spray applied samples for a 4 feet long sample of most common exposed extrusion and for a 1 foot by 4 feet sample of spray applied coating on sheet aluminum. Indicate grain direction on back of both.
 3. Provide a 1 foot by 4 feet sample of coil-coating on each indicated substrate. Indicate grain direction on back.
- E. Delegated-Design Submittal: Analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
 3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design louvers, including comprehensive engineering analysis by a qualified professional engineer, using structural performance requirements and design criteria indicated.
- B. Comply with performance criteria indicated in Section 01 83 16 "Exterior Enclosure General Requirements" and additional criteria indicated herein.
- C. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

- D. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

2.3 FIXED, EXTRUDED-ALUMINUM LOUVERS

A. Horizontal, Wind-driven Rain Resistant Louver:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Ruskin EME720 or comparable product by one of the following:
 - a. All-Lite Architectural Products.
 - b. Architectural Louvers; Harray, LLC.
 - c. Arrow United Industries; a division of Mestek, Inc.
 - d. Construction Specialties, Inc.
 - e. Greenheck Fan Corporation.
 - f. Pottorff.
 - g. Ruskin Company; Tomkins PLC.
2. Blades: Horizontal, hook type.
3. Frame: Perimeter frame closed back for sealing to air barrier.
4. Vertical mullions: NA.
5. Louver Depth: 7 inches.
6. Frame and Blade Nominal Thickness: Not less than 0.080 inch.
7. Louver Performance Ratings:
 - a. Free Area: Not less than 55% for 48-inch-wide by 48-inch- high louver.
 - b. Maximum Free Area Velocity:
 - 1) Intake: 750 feet per minute
 - 2) Exhaust: 1,000 feet per minute
 - c. Water Penetration: Less than 0.14 ounce per square foot. 15 minute duration at 750 feet per minute.
 - d. Point of Beginning Water Penetration: Not less than 1,100 cfm.
 - e. Air Performance: Not more than 0.40-inch wg static pressure drop at 1,100 cfm intake.
 - f. Tested in accordance with the AMCA 500-L Wind-Driven Rain Penetration Test, Class A

2.4 LOUVER SCREENS

A. General: Provide screen at each exterior louver.

1. Screen Location for Fixed Louvers: Interior face.
2. Screening Type: Bird screening.

- B. Secure screen frames to louver frames with machine screws with heads finished to match louver, spaced a maximum of 6 inches from each corner and at 12 inches o.c.
- C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.
 - 1. Metal: Same type and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips.
 - 2. Finish: Same finish as louver frames to which louver screens are attached.
 - 3. Type: Non-rewirable, U-shaped frames.
- D. Louver Screening for Aluminum Louvers:
 - 1. Bird Screening: Aluminum, 1/2-inch- square mesh, 0.063-inch wire.

2.5 BLANK-OFF PANELS

- A. Insulated, Blank-Off Panels: Laminated panels consisting of an insulating core surfaced on back and front with metal sheets and attached to back of louver.
 - 1. Provide blank-off panel at all unused portions of supply and exhaust louvers.
 - 2. Thickness: 3 inch.
 - 3. Metal Facing Sheets: 18 gage galvanized steel sheet.
 - 4. Insulating Core: Non-combustible rigid mineral board.
 - 5. Edge Treatment: Trim perimeter edges of blank-off panels with extruded-aluminum-channel frames, not less than 0.080-inch nominal thickness, with corners mitered and with same finish as panels.
 - 6. Seal perimeter joints between panel faces and louver frames with gaskets or sealant.
 - 7. Panel Finish: Same type of finish applied to louvers, but black color.
 - 8. Attach blank-off panels with clips.

2.6 MATERIALS

- A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5, T-52, or T6.
- B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- C. Fasteners: Use types and sizes to suit unit installation conditions.
 - 1. Use aluminum or 300 series stainless-steel fasteners hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.
 - 2. For color-finished louvers, use fasteners with heads that match color of louvers.
- D. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load

imposed for masonry, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.7 FABRICATION

- A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.
 - 1. Continuous Vertical Assemblies: Fabricate units without interrupting blade-spacing pattern.
- C. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.
- D. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
 - 1. Frame Type: Exterior flange sized to glaze into the adjacent window wall or curtain wall frame unless otherwise indicated.
- E. Include supports, anchorages, and accessories required for complete assembly.
- F. Provide recessed drainable vertical mullions of type and at spacings indicated, but not more than 72 inches o.c., whichever is less.
- G. Join frame members to each other and to fixed louver blades with fillet welds concealed from view unless size of louver assembly makes bolted connections between frame members necessary.

2.8 ALUMINUM FINISHES

- A. Comply with requirements indicated in Section 01 83 16 for Coated Metal Color Control in addition to requirements specified herein for coordination, sourcing limits, color variation tolerances,
- B. Finish louvers after assembly.
- C. High-Performance Organic Finish:

1. Two-coat mica fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF or FEVE resin by weight in color coat.
2. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
3. Color and Gloss: Match Architect's sample for each color.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

- A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages.
- C. Form closely fitted joints with exposed connections accurately located and secured.
- D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Install watertight sill pan flashing with no penetrations in the horizontal area.
- F. Install insulated blank-off panels so that any water trapped between panel and back of louvers is directed into sill pan.
- G. Protect unpainted galvanized and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

- H. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 07 92 00 "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

- A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.
- B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- C. Restore louvers damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
 - 1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION

SECTION 090190
MAINTENANCE EXTERIOR REPAINTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes maintenance repainting of existing exterior surfaces as follows:
 - 1. Removing existing paint.
 - 2. Patching substrates.
 - 3. Repainting.
 - 4. Painting newly patched or repaired surfaces on the exterior.
 - 5. Surfaces on the interior side of windows and doors indicated to be replaced.
- B. Related Requirements:
 - 1. Section 040110 "Masonry Cleaning" for cleaning and removing paint from masonry.
 - 2. Section 060050 "Repair of Exterior Carpentry".
 - 3. Section 080152 "Wood Window Repair"
 - 4. Section 099610 "Exterior HPC"
 - 5. Section 099726 "Mineral Coating"

1.2 ALLOWANCES

- A. Allowances for maintenance repainting are specified in Section 012100 "Allowances."

1.3 UNIT PRICES

- A. Work of this Section is affected by unit prices specified in Section 012200 "Unit Prices."
 - 1. Unit prices apply to authorized additions to and deletions from Work as authorized by Change Orders.

1.4 DEFINITIONS

- A. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.
- B. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.

- C. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.
- D. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D523.
- E. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.
- F. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.
- G. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.
- H. Low-Pressure Spray: 100 to 400 psi; 4 to 6 gpm.
- I. Medium-Pressure Spray: 400 to 800 psi; 4 to 6 gpm.

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site

1.6 SEQUENCING AND SCHEDULING

- A. Perform maintenance repainting in the following sequence, which includes work specified in this and other Sections:
 - 1. Dismantle existing surface-mounted objects and hardware except items indicated to remain in place. Tag items with location identification and protect.
 - 2. Verify that temporary protections have been installed.
 - 3. Examine condition of surfaces to be painted.
 - 4. Remove existing paint to the degree required for each substrate and surface condition of existing paint.
 - 5. Apply paint system.
 - 6. Reinstall dismantled surface-mounted objects and hardware unless otherwise indicated.

1.7 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include recommendations for product application and use.
 - 2. Include test data substantiating that products comply with requirements.
- B. Samples: For each type of paint system and each pattern, color, and gloss; minimum 6 inches wide by 24 inches long.

1. Include stepped Samples defining each separate coat, including fillers and primers. Resubmit until each required sheen, color, and texture is achieved.
2. Include a list of materials for each coat of each Sample.
3. Label each Sample for location and application.

C. Product List: For each paint 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.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra paint materials, from the same production run, that match products applied and that are packaged with protective covering for storage and identified with labels describing contents, including material, finish, source, and location on building.

1. Quantity: Furnish Owner with an additional 3percent, but not less than 1 gal. (3.8 L) or one case, as appropriate, of each material and color applied.

1.9 QUALITY ASSURANCE

A. Mockups: Prepare mockups of maintenance repainting processes for each type of coating system and substrate indicated and each color and finish required to demonstrate aesthetic effects and to set quality standards for materials and execution. Duplicate appearance of approved Sample submittals.

1. Mockup one existing window.
2. Surface-Preparation Mockups: On existing surfaces using applicable specified methods of cleaning and other surface preparation, provide mockup sample of at least
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste daily.

1.11 FIELD CONDITIONS

- A. Weather Limitations: Proceed with maintenance repainting only when existing and forecasted weather conditions are within the environmental limits set by each manufacturer's written instructions and specified requirements.
- B. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
- C. Do not apply paint in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.
 - 1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer for surface preparation and during paint application and drying periods.

PART 2 - PRODUCTS

2.1 PREPARATORY CLEANING MATERIALS

- A. Water: Potable.
- B. Hot Water: Water heated to a temperature of 140 to 160 deg F (60 to 71 deg C).
- C. Detergent Solution: Solution prepared by mixing 2 cups (0.5 L) of tetrasodium pyrophosphate (TSP), 1/2 cup (125 mL) of laundry detergent that contains no ammonia, 5 quarts (5 L) of 5 percent sodium hypochlorite bleach, and 15 quarts (15 L) of warm water for every 5 gal. (20 L) of solution required.
- D. Mildewcide: Commercial proprietary mildewcide or a job-mixed solution prepared by mixing 1/3 cup (80 mL) of household detergent that contains no ammonia, 1 quart (1 L) of 5 percent sodium hypochlorite bleach, and 3 quarts (3 L) of warm water.
- E. Abrasives for Ferrous Metal Cleaning: Aluminum oxide paper, emery paper, fine steel wool, steel scrapers, and steel-wire brushes of various sizes.
- F. Rust Remover: Manufacturer's standard phosphoric acid-based gel formulation, also called "naval jelly," for removing corrosion from iron and steel.

2.2 PAINT REMOVERS

- A. Alkaline Paste Paint Remover: Manufacturer's standard alkaline paste or gel formulation for removing paint from masonry, stone, wood, plaster, or metal as required to suit Project; and containing no methylene chloride.

- B. Covered or Skin-Forming Alkaline Paint Remover: Manufacturer's standard covered or skin-forming alkaline paste or gel formulation for removing paint from masonry, stone, wood, plaster, or metal as required to suit Project; and containing no methylene chloride.
- C. Solvent-Type Paste Paint Remover: Manufacturer's standard water-rinsable, solvent-type paste or gel formulation for removing paint from masonry, stone, wood, plaster, or metal as required to suit Project.
- D. Low-Odor, Solvent-Type Paste Paint Remover: Manufacturer's standard low-odor, water-rinsable, solvent-type paste, gel, or foamed emulsion formulation for removing paint from masonry, stone, wood, plaster, or metal as required to suit Project; and containing no methanol or methylene chloride.
- E. Covered, Solvent-Type Paste Paint Remover: Manufacturer's standard, low-odor, covered, water-rinsable, solvent-type paste or gel formulation for removing paint from masonry, stone, wood, plaster, or metal as required to suit Project; and containing no methanol or methylene chloride.

2.3 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: custom color to Match Architect's samples.

2.4 PAINT MATERIALS, GENERAL

- A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."
- B. Transition Coat: Paint manufacturer's recommended coating for use where a residual existing coating is incompatible with the paint system.

2.5 PAINT MATERIAL MANUFACTURERS

2.6 PAINT MATERIALS

- A. Primers and Sealers:

1. Primer, Stain Blocking, Water Based: MPI #137.

B. Metal Primers:

1. Primer, Metal, Surface Tolerant: MPI #23.
2. Primer, Alkyd, Anti-Corrosive for Metal: MPI #79.
3. Primer, Rust-Inhibitive, Water Based: MPI #107.
4. Primer, Zinc Rich, Organic: MPI #18.
5. Primer, Zinc-Rich, Epoxy: MPI #20.
6. Primer, Epoxy, Anti-Corrosive, for Metal: MPI #101.

C. Wood Primers:

1. Primer, Latex for Exterior Wood: MPI #6.
2. Primer, Alkyd for Exterior Wood: MPI #5.

D. Water-Based Paints:

1. Latex, Exterior Flat (Gloss Level 1): MPI #10.
2. Latex, Exterior Low Sheen (Gloss Levels 3-4): MPI #15.
3. Latex, Exterior Semigloss (Gloss Level 5): MPI #11.
4. Latex, Exterior, Gloss (Gloss Level 6): MPI #119.

E. Solvent-Based Paints:

1. Alkyd, Exterior Flat (Gloss Level 1): MPI #8.
2. Alkyd, Exterior, Semigloss (Gloss Level 5): MPI #94.
3. Alkyd, Exterior Gloss (Gloss Level 6): MPI #9.

2.7 PATCHING MATERIALS

- A. Wood-Patching Compound: Two-part, epoxy-resin, wood-patching compound; knife-grade formulation as recommended in writing by manufacturer for type of wood repair indicated, tooling time required for the detail of work, and site conditions. Compound shall be designed for filling voids in damaged wood materials that have deteriorated from weathering and decay. Compound shall be capable of filling deep holes and spreading to feather edge.
- B. Metal-Patching Compound: Two-part, polyester-resin, metal-patching compound; knife-grade formulation as recommended in writing by manufacturer for type of metal repair indicated, tooling time required for the detail of work, and site conditions. Compound shall be produced for filling metal that has deteriorated from corrosion. Filler shall be capable of filling deep holes and spreading to feather edge.
- C. Cementitious Patching Compounds: Cementitious patching compounds and repair materials specifically manufactured for filling cementitious substrates and for sanding or tooling prior to repainting; formulation as recommended in writing by manufacturer

for type of cementitious substrate indicated, exposure to weather and traffic, the detail of work, and site conditions.

PART 3 - EXECUTION

3.1 PROTECTION

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

3.2 MAINTENANCE REPAINTING, GENERAL

- A. Maintenance Repainting Appearance Standard: Completed work is to have a uniform appearance as viewed by Architect at 3 feet away from painted surface except at 10 feet away from painted surface on exterior of building when there is no walkway or pavement or other similar hard surface providing pedestrian access to the painted surface.
- B. Execution of the Work: In repainting surfaces, disturb them as minimally as possible and as follows:
 - 1. Remove failed coatings and corrosion and repaint.
 - 2. Verify that substrate surface conditions are suitable for repainting.
 - 3. Allow other trades to repair items in place before repainting.
- C. Mechanical Abrasion: Where mechanical abrasion is needed for the work, use gentle methods, such as scraping and lightly hand sanding, that will not abrade softer substrates, reducing clarity of detail.
- D. Heat Processes: Do not use torches, heat guns, or heat plates.

3.3 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of painting work. Comply with paint manufacturer's written instructions for inspection.
- B. Maximum Moisture Content of Substrates: Do not begin application of coatings unless moisture content of exposed surface is below the maximum value recommended in writing by paint manufacturer and not greater than the following maximum values when measured with an electronic moisture meter appropriate to the substrate material:
 - 1. Concrete: 12 percent.
 - 2. Gypsum Board: 12 percent.
 - 3. Gypsum Plaster: 12 percent.
 - 4. Masonry (Clay and CMU): 12 percent.
 - 5. Portland Cement Plaster: 12 percent.
 - 6. Wood: 15 percent.
- C. Alkalinity: Do not begin application of coatings unless surface alkalinity is within range recommended in writing by paint manufacturer. Conduct alkali testing with litmus paper on exposed plaster, cementitious, and masonry surfaces.
- D. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
 - 1. If existing surfaces cannot be prepared to an acceptable condition for proper finishing by using specified surface-preparation methods, notify Architect in writing.
- E. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
 - 1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.4 PREPARATORY CLEANING

- A. General: Use the gentlest, appropriate method necessary to clean surfaces in preparation for painting. Clean all surfaces, corners, contours, and interstices.
- B. Detergent Cleaning: Wash surfaces by hand using clean rags, sponges, and bristle brushes. Scrub surface with detergent solution and bristle brush until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that surface remains wet. Rinse with water applied by clean rags or sponges.

- C. Solvent Cleaning: Use solvent cleaning to remove oil, grease, smoke, tar, and asphalt from painted or unpainted surfaces before other preparation work. Wipe surfaces with solvent using clean rags and sponges. If necessary, spot-solvent cleaning may be employed just prior to commencement of paint application, provided enough time is allowed for complete evaporation. Use clean solvent and clean rags for the final wash to ensure that all foreign materials have been removed. Do not use solvents, including primer thinner and turpentine, that leave residue.
- D. Mildew: Clean off existing mildew, algae, moss, plant material, loose paint, grease, dirt, and other debris by scrubbing with bristle brush or sponge and detergent solution. Scrub mildewed areas with mildewcide. Rinse with water applied by clean rags or sponges.
- E. Chemical Rust Removal:
 - 1. Remove loose rust scale with specified abrasives for ferrous-metal cleaning.
 - 2. Apply rust remover with brushes or as recommended in writing by manufacturer.
 - 3. Allow rust remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing. Do not allow extended dwell time.
 - 4. Wipe off residue with mineral spirits and either steel wool or soft rags, or clean with method recommended in writing by manufacturer to remove residue.
 - 5. Dry immediately with clean, soft cloths. Follow direction of grain in metal.
 - 6. Prime immediately to prevent rust. Do not touch cleaned metal surface until primed.
- F. Mechanical Rust Removal:
 - 1. Remove rust with specified abrasives for ferrous-metal cleaning. Clean to bright metal.
 - 2. Wipe off residue with mineral spirits and either steel wool or soft rags.
 - 3. Dry immediately with clean, soft cloths. Follow direction of grain in metal.
 - 4. Prime immediately to prevent rust. Do not touch cleaned metal surface until primed.

3.5 PAINT REMOVAL

- A. General: Remove paint where indicated. Where cleaning methods have been attempted and further removal of the paint is required because of incompatible or unsatisfactory surfaces for repainting, remove paint to extent required by conditions.
 - 1. Application: Apply paint removers according to paint-remover manufacturer's written instructions. Do not allow paint removers to remain on surface for periods longer than those indicated or recommended in writing by manufacturer.
 - a. Apply materials to all surfaces, corners, contours, and interstices, to provide a uniform final appearance without streaks.

- b. After work is complete, remove protection no longer required. Remove tape and adhesive marks.
 2. Brushes: Use brushes that are resistant to chemicals being used.
 - a. Metal Substrates: If using wire brushes on metal, use brushes of same metal composition as metal being treated.
 - b. Wood Substrates: Do not use wire brushes.
 3. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that spray methods do not damage surfaces.
 - a. Equip units with pressure gages.
 - b. Unless otherwise indicated, hold spray nozzle at least 6 inches (150 mm) from surface and apply material in horizontal, back-and-forth sweeping motion, overlapping previous strokes to produce uniform coverage.
 - c. For chemical spray application, use low-pressure tank or chemical pump suitable for chemical indicated, equipped with nozzle having a cone-shaped spray.
 - d. For water-spray application, use fan-shaped spray tip that disperses water at an angle of 25 to 50 degrees.
 - e. For heated water-spray application, use equipment capable of maintaining temperature between 140 and 160 deg F (60 and 71 deg C) at flow rates indicated.
- B. Paint Removal with Hand Tools: Remove paint manually using hand-held scrapers, wire brushes, sandpaper, and metallic wool as appropriate for the substrate material.
- C. Paint Removal with Alkaline Paste Paint Remover:
 1. Remove loose and peeling paint using scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
 2. Apply paint remover to dry, painted surface with brushes.
 3. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
 4. Rinse with water applied by low-pressure spray to remove chemicals and paint residue.
 5. Use mechanical methods recommended in writing by manufacturer to remove chemicals and paint residue.
 6. Repeat process if necessary to remove all paint.
- D. Paint Removal with Covered or Skin-Forming Alkaline Paint Remover:
 1. Remove loose and peeling paint using scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
 2. Apply paint remover to dry, painted surface with brushes or as recommended in writing by manufacturer.
 3. Apply cover according to manufacturer's written instructions.

4. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
5. Scrape off paint and remover.
6. Rinse with water applied by low pressure spray to remove chemicals and paint residue.
7. Use mechanical methods recommended in writing by manufacturer to remove chemicals and paint residue.
8. For spots of remaining paint, apply alkaline paste paint remover according to "Paint Removal with Alkaline Paste Paint Remover" Paragraph.

E. Paint Removal with Solvent-Type Paste Paint Remover:

1. Remove loose and peeling paint using scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply thick coating of paint remover to dry, painted surface with natural-fiber cleaning brush, deep-nap roller, or large paintbrush. Apply in one or two coats according to manufacturer's written instructions.
3. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
4. Rinse with water applied by medium-pressure spray to remove chemicals and paint residue.
5. Use mechanical methods recommended in writing by manufacturer to remove chemicals and paint residue.
6. Repeat process if necessary to remove all paint.

F. Paint Removal with Covered, Solvent-Type Paste Paint Remover:

1. Remove loose and peeling paint using scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply paint remover to dry, painted surface with natural-fiber cleaning brush, deep-nap roller, or large paint brush or as recommended in writing by manufacturer.
3. Apply cover according to manufacturer's written instructions.
4. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
5. Scrape off paint and remover.
6. Rinse with water applied by lowpressure spray to remove chemicals and paint residue.
7. Use mechanical methods recommended in writing by manufacturer to remove remaining chemicals and paint residue.

3.6 SUBSTRATE REPAIR

- A. General: Repair substrate surface defects that are inconsistent with the surface appearance of adjacent materials and finishes.
- B. Wood Substrate: Refer to Section 060050 "Repair of Exterior Carpentry" and Section 080152 "Wood Window Repair"

C. Cementitious Material Substrate:

1. General: Repair defects including dents and chips between 1/16 inch and 1/4 inch in size and all holes and cracks by filling with cementitious patching compound and sanding smooth. Remove protruding fasteners. Larger defects shall be repaired with dutchman as specified in section 090050 Repair of Exterior Plaster
2. New and Bare Plaster: Neutralize surface of plaster with mild acid solution as recommended in writing by paint manufacturer. In lieu of acid neutralization, follow manufacturer's written instruction for primer or transition coat over alkaline plaster surfaces.
3. Concrete, Cement Plaster, and Other Cementitious Products: Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. If surfaces are too alkaline to paint, correct this condition before painting. Coordinate with work of section 040100 Masonry Repair and Section 040110 Masonry Cleaning.

D. Metal Substrate:

1. Preparation: Treat repair locations by wire-brushing and solvent cleaning. Use chemical or mechanical rust removal method to clean off rust.
2. Defects in Metal Surfaces: Repair non-load-bearing defects in existing metal surfaces, including dents and gouges more than 1/16 inch deep or 1 inch across and all holes and cracks by filling with metal-patching compound and sanding smooth. Remove burrs and protruding fasteners. Larger defects shall be repaired per Section 050100 Exterior Metal Repair
3. Priming: Prime iron and steel surfaces immediately after repair to prevent flash rusting. Stripe paint corners, crevices, bolts, welds, and sharp edges. Apply two coats to surfaces that are inaccessible after completion of the Work.

3.7 PAINT APPLICATION, GENERAL

- A. Comply with manufacturers' written instructions for application methods unless otherwise indicated in this Section.
- B. Prepare surfaces to be painted according to the Surface-Preparation Schedule and with manufacturer's written instructions for each substrate condition.
- C. Apply a transition coat over incompatible existing coatings.
- D. Metal Substrate: Stripe paint corners, crevices, bolts, welds, and sharp edges before applying full coat. Apply two coats to surfaces that are inaccessible after completion of the Work. Tint stripe coat different than the main coating and apply with brush.
- E. Blending Painted Surfaces: When painting new substrates patched into existing surfaces or touching up missing or damaged finishes, apply coating system specified for the specific substrate. Apply final finish coat over entire surface from edge to edge and corner to corner.

3.8 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage paint-remover manufacturer's factory-authorized service representative for consultation and Project-site inspection and to provide on-site assistance when requested by Architect.
- B. Paint Material Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for composition and dry film thickness.
 - 1. Paint Composition: The following procedure may be performed at any time and as often as Owner deems necessary during the period when paints are being applied:
 - a. Testing agency will sample paint materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
 - b. Testing agency will perform tests for compliance of paint materials with product requirements.
 - c. If test results show materials being used do not comply with product requirements, Contractor shall remove noncomplying-paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.
 - 2. Dry Film Thickness:
 - a. Contractor shall touch up and restore painted surfaces damaged by testing.
 - b. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written instructions, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written instructions.

3.9 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.

3.10 SURFACE-PREPARATION SCHEDULE

- A. Coat every existing surface that has been previously been coated unless otherwise indicated to be coated or does not require applied coating finish.
- B. General: Before painting, prepare surfaces where indicated on Drawings for painting according to applicable requirements specified in this schedule.
 - 1. Examine surfaces to evaluate each surface condition according to paragraphs below.
 - 2. Where existing degree of soiling prevents examination, preclean surface and allow it to dry before making an evaluation.
 - 3. Repair substrate defects according to "Substrate Repair" Article.
- C. Surface Preparation for MPI DSD Degree of Surface Degradation:
 - 1. Surface Condition: Existing paint film in good condition and tightly adhered.
 - 2. Paint Removal: Not required.
 - 3. Preparation for Painting: Wash surface by detergent cleaning; use solvent cleaning where needed. Roughen or degloss cleaned surfaces to ensure paint adhesion according to paint manufacturer's written instructions.
- D. Surface Preparation for MPI DSD 1 Degree of Surface Degradation:
 - 1. Surface Condition: Paint film cracked or broken but adhered.
 - 2. Paint Removal: Scrape by hand-tool cleaning methods to remove loose paint until only tightly adhered paint remains.
 - 3. Preparation for Painting: Wash surface by detergent cleaning; use other cleaning methods for small areas of bare substrate if required. Roughen, degloss, and sand the cleaned surfaces to ensure paint adhesion and a smooth finish according to paint manufacturer's written instructions.
- E. Surface Preparation for MPI DSD 2 Degree of Surface Degradation:
 - 1. Surface Condition: Paint film loose, flaking, or peeling.
 - 2. Paint Removal: Remove loose, flaking, or peeling paint film by hand-tool or chemical paint-removal methods.
 - 3. Preparation for Painting: Wash surface by detergent cleaning; use solvent cleaning where needed. Use other cleaning methods for small areas of bare substrate if required. Sand surfaces to smooth remaining paint film edges. Prepare bare cleaned surface to be painted according to paint manufacturer's written instructions for substrate construction materials.
- F. Surface Preparation for MPI DSD 3 Degree of Surface Degradation:
 - 1. Surface Condition: Paint film severely deteriorated and surface indicated to have paint completely removed.
 - 2. Paint Removal: Completely remove paint film by hand-tool or chemical paint-removal methods. Remove rust.

3. Preparation for Painting: Prepare bare cleaned surface according to paint manufacturer's written instructions for substrate construction materials.

G. Surface Preparation for MPI DSD 4 Degree of Surface Degradation:

1. Surface Condition: Missing material, small holes and openings, and deteriorated or corroded substrate.
2. Substrate Preparation: Repair, replace, and treat substrate according to "Substrate Repair" Article and requirements in other Specification Sections
3. Preparation for Painting: Sand substrate surfaces to smooth remaining paint film edges and prepare according to paint manufacturer's written instructions for substrate construction materials. Remove rust.
4. Painting: Paint as required for MPI DSD 2 degree of surface degradation.

3.11 EXTERIOR MAINTENANCE REPAINTING SCHEDULE

A. Ferrous Metal Substrates:

1. High-Performance, Pigmented-Polyurethane-over-Epoxy System: MPI REX 5.1H
 - a. Prime Coat: For MPI DSD 1 degree of surface degradation, touch up with topcoat.
 - b. Prime Coat: For MPI DSD 2 degree of surface degradation, spot prime with Primer, Epoxy, Anti-Corrosive, for Metal, MPI #101.
 - c. Prime Coat: For MPI DSD 3 degree of surface degradation, fully prime coat with Primer, Epoxy, Anti-Corrosive, for Metal, MPI #101.
 - d. Intermediate Coat in Primed Areas: Epoxy, High Build, Low Gloss, MPI #108.
 - e. Topcoat: Polyurethane, two-component, pigmented, gloss (Gloss Level 6), MPI #72.
 - f. Second Topcoat: Polyurethane, two-component, pigmented, gloss (Gloss Level 6), MPI #72.
 - g. Color: Match Architect's sample

B. Wood

1. Latex System: MPI REX 6.3A
 - a. Prime Coat: For MPI DSD 1 degree of surface degradation, touch up with topcoat.
 - b. Prime Coat: For MPI DSD 2 degree of surface degradation, spot prime with Primer, Alkyd for Exterior Wood, MPI #5.
 - c. Prime Coat: For MPI DSD 3 degree of surface degradation, fully prime coat with Primer, Alkyd for Exterior Wood, MPI #5.
 - d. Intermediate Coat: Latex, exterior, matching topcoat
 - e. Topcoat: Latex, exterior flat (Gloss Levels 1-2), MPI #10.
 - f. Topcoat: Latex, exterior, low sheen (Gloss Levels 3-4), MPI #15.
 - g. Topcoat: Latex, exterior semigloss (Gloss Level 5), MPI #11.

- h. Topcoat: Latex, exterior gloss (Gloss Level 6), MPI #119.
- i. Color: Match Architects Sample

END OF SECTION

SECTION 09 05 61

COMMON WORK RESULTS FOR FLOORING PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

A. Work Results:

1. Remove existing floor coverings.
2. Test concrete floor slabs for moisture and alkalinity.
3. Prepare existing and new concrete slabs for the following flooring types:
 - a. Resilient tile and sheet.
 - b. Broadloom or tile carpet.
 - c. Porcelain tile.
 - d. Precast terrazzo.
4. Remediate concrete floor slabs due to unsatisfactory moisture or alkalinity conditions.

B. Principal Products:

1. Testing apparatus.
2. Patching and self-leveling compounds.
3. Remedial floor coatings.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination Procedures:

1. Coordinate work results of this section with manufacturer recommendations for specified finish flooring types.

B. Preinstallation Meeting Attendees and Procedures:

1. Conduct meeting one week, minimum, before starting Work of this Section.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Floor Covering and Adhesive Manufacturer Product Literature: For each specific combination of substrate, floor covering, and adhesive to be used; showing:
 - a. Moisture and alkalinity limits and test methods.
 - b. Manufacturer required bond/compatibility test procedure.

2. Remedial Materials:

- a. Test reports indicating compliance with specified performance requirements, performed by nationally recognized independent testing agency.

1.4 INFORMATIONAL SUBMITTALS

- A. Visual Observation Report: For existing floor coverings to be removed.
- B. Testing Agency Report:
 1. Description of areas tested; include floor plans and photographs if helpful.
 2. Summary of conditions encountered.
 3. Moisture and alkalinity test reports.
 4. Copies of specified test methods.
 5. Recommendations for remediation of unsatisfactory surfaces.
 6. Include certification of accuracy by authorized official of testing agency.
 7. Submit report to Architect two Business Days, maximum after conclusion of testing.
- C. Adhesive Bond and Compatibility Test Report.
- D. Specimen Warranty: Issued by remedial material manufacturer.

1.5 CLOSEOUT SUBMITTALS

- A. Warranty Documentation: For remedial floor coatings.

1.6 QUALITY ASSURANCE

- A. Testing Agency: Employ and pay for an independent testing agency to perform moisture and alkalinity testing.
 1. Qualifications: Experienced in specified testing methods.
 2. Contractor Responsibility Relating to Independent Agency Testing:
 - a. Provide access for and cooperate with testing agency.
 - b. Confirm date of start of testing at least 10 days before actual start.
 - c. Allow at least 4 Business Days on site for testing agency activities.
 - d. Achieve and maintain specified ambient conditions.
 - e. Notify Owner when specified ambient conditions have been achieved and when testing will start.
- B. Mockup: Construct and test mockup per ASTM F3010.
- C. Remedial Coating Installer Qualifications: Flooring preparation specialist company, trained or employed by coating manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store materials in manufacturer packaging; include installation instructions.
- B. Keep materials from freezing.

1.8 FIELD CONDITIONS

- A. Maintain ambient temperature in spaces where concrete testing is being performed, and for at least 48 hours before testing, at not less than 65 degrees F or more than 85 degrees F.
- B. Maintain relative humidity in spaces where concrete testing is being performed, and for at least 48 hours before testing, at not less than 40 percent and not more than 60 percent.

PART 2 - PRODUCTS

2.1 FLOORING PREPARATION MATERIALS

- A. Patching and Self-Leveling Compound:
 - 1. Cementitious moisture, mildew, and alkali resistant compound, compatible with floor, floor covering, and floor covering adhesive, capable of being installed to thicknesses shown, and feathered to nothing at edges.
 - 2. Compressive Strength: 4000 psi, minimum after 28 days per ASTM C109/C109M or ASTM C472, whichever is appropriate.
- B. Flooring Adhesive: Floor covering or adhesive manufacturer recommended product, suitable for the moisture and pH conditions present.
 - 1. VOC Content: 50 g/L, maximum.
- C. Remedial Floor Coating: Single or multilayer coating or coating/overlay combination.
 - 1. Manufacturers and Products: Testing agency recommended or one of the following:
 - a. ARDEX Engineered Cements ARDEX VB 100 with ARDEX V 1200.
 - b. Custom Building Products CustomTech Tech MVC with TechLevel 100.
 - c. Dependable Floor Products; Platform EMS with SKIMFLOW LP.
 - d. KOSTER American Corporation KOSTER VAP I 2000 FS with KOSTER LevelStrong.
 - e. LATICRETE International, Inc. Vapor Ban with NXT Level.
 - f. MAPEI Planiseal VS with Ultraplan Easy.
 - g. UZIN; UZIN PE 460 with UZIN NC 157.
 - 2. Primer: Manufacturer recommended for selected assembly.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

- A. Follow ASTM F3010.

3.2 CONCRETE SLAB PREPARATION - LIGHTWEIGHT CONCRETE

- A. Testing: Relative humidity and pH testing is not required.
- B. Remediation: Apply remedial floor coating system over entire floor area.

3.3 CONCRETE SLAB PREPARATION - NORMAL WEIGHT CONCRETE

- A. Follow recommendations of testing agency and ASTM F3010.
- B. Perform following operations in this order:
 - 1. Existing on-grade and elevated concrete slabs with existing floor coverings:
 - a. Observe existing floor covering for adhesion, water damage, alkaline deposits, and other defects.
 - b. Remove existing floor covering.
 - 2. Existing concrete slabs with coatings or penetrating sealers/hardeners/dustproofers:
 - a. Do not attempt to remove coating or penetrating material.
 - b. Do not abrade surface.
 - 3. Perform preliminary cleaning.
 - 4. Internal Relative Humidity Testing: Three tests in the first 1000 square feet and one test in each additional 1000 square feet, or flooring manufacturer recommended frequency.
 - 5. Alkalinity Tests: Relative humidity test locations.
 - 6. Specified remediation, if required due to relative humidity test result.
 - 7. Patching, smoothing, and leveling.
 - 8. Other preparation specified in finish flooring sections.
 - 9. Adhesive bond and compatibility test.
 - 10. Apply protection.
- C. Remediations:
 - 1. Active Water Leaks or Continuing Moisture Migration to Surface of Slab: Correct before doing any other remediation; retest after correction.
 - 2. Excessive Relative Humidity: If an adhesive that is resistant to the level of moisture present is available and acceptable to flooring manufacturer, use that adhesive for installation of the flooring; if not, apply remedial floor coating over entire suspect floor area.
 - 3. Excessive Alkalinity:

- a. If remedial floor coating is necessary to address excessive moisture, no additional remediation is required for pH.
- b. If an adhesive that is resistant to the pH level present is available and acceptable to the flooring manufacturer, use that adhesive for installation of the flooring; otherwise, apply a skim coat of specified patching compound over entire suspect floor area.

3.4 EXISTING FLOOR COVERINGS REMOVAL

- A. Follow local, State, and federal regulations and RFCI Recommended Work Practices for Removal of Resilient Floor Coverings, applicable to floor covering being removed.

3.5 PRELIMINARY CLEANING

- A. Clean floors, remove adhesion inhibiting substances.
- B. Do not use solvents for cleaning.

3.6 INTERNAL RELATIVE HUMIDITY TESTING

- A. Where the floor covering manufacturer requirements conflict with either the referenced test method or this Specification, follow the manufacturer requirements.
- B. Testing: ASTM F2170 Procedure A. Calcium Chloride and electrical impedance or resistance testing may not be substituted.
- C. If test values exceed floor covering manufacturer limits, perform remediation. In the absence of manufacturer limits, perform remediation if any test value exceeds 75 percent relative humidity.
- D. Report the information required by the test method.

3.7 ALKALINITY TESTING

- A. Where the floor covering manufacturer requirements conflict with either the referenced test method or this Specification, follow the manufacturer requirements.
- B. Use a wide range alkalinity test paper, its associated chart, and distilled or deionized water.
- C. Place several drops of water on a clean surface of concrete, forming a puddle approximately 1 inch in diameter. Allow the puddle to set for approximately 60 seconds, then dip the alkalinity test paper into the water, remove it, and compare immediately to chart to determine alkalinity reading.
- D. In the event that test values exceed floor covering manufacturer limits, perform remediation. In the absence of manufacturer limits, perform remediation if alkalinity test value exceeds 10.

3.8 PREPARATION

- A. See individual floor covering sections for additional requirements.

- B. Follow recommendations of testing agency.
- C. Fill and smooth surface cracks, grooves, depressions, control joints and other nonmoving joints, and other irregularities with patching compound.
- D. Do not fill expansion joints, isolation joints, or other moving joints.

3.9 ADHESIVE BOND AND COMPATIBILITY TESTING

- A. Follow requirements and recommendations of floor covering manufacturer.

3.10 APPLICATION OF REMEDIAL FLOOR COATING

- A. Mix and apply remedial floor coating.
 - 1. Prohibit traffic during application.
 - 2. Honor substrate control, isolation and expansion joints.
 - 3. Prime substrate, and apply floor coating in layers as recommended by manufacturer.
 - 4. Allow coating to cure before applying finish flooring.

3.11 PROTECTION

- A. Cover prepared floors with building paper or other durable covering until finish flooring is installed.

END OF SECTION

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SECTION 09 21 16.23

GYPSUM BOARD SHAFT WALL ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Gypsum board shaft wall assemblies.

1.2 ACTION SUBMITTALS

- A. Product Data:** For each component of gypsum board shaft wall assembly.

1.3 DELIVERY, STORAGE, AND HANDLING

- A.** Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and support them on risers on a flat platform to prevent sagging.

1.4 FIELD CONDITIONS

- A.** Environmental Limitations: Comply with gypsum-shaftliner-board manufacturer written instructions.
- B.** Do not install finish panels until installation areas are enclosed and conditioned.
- C.** Do not install panels that are wet, moisture damaged, or mold damaged.
1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.
- B. STC-Rated Assemblies: Provide materials and construction identical to those of assemblies tested according to ASTM E90 and classified according to ASTM E413 by a testing and inspecting agency.

2.2 GYPSUM BOARD SHAFT WALL ASSEMBLIES

- A. Fire-Resistance Rating: See Drawings.
- B. STC Rating: See Drawings.
- C. Gypsum Shaftliner Board:
 - 1. Moisture- and Mold-Resistant, Fiberglass-Mat Faced: ASTM C1658/C1658M; manufacturer proprietary fire-resistive liner panels with ASTM D3273 mold-resistance score of 10 as rated according to ASTM D3274, 1 inch (25.4 mm) thick, and with double beveled long edges.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) CertainTeed Corp.; ProRoc Moisture and Mold Resistant Shaftliner.
 - 2) Georgia-Pacific Gypsum LLC, Subsidiary of Georgia Pacific; Dens-Glass Ultra Shaftliner.
 - 3) National Gypsum Company; Gold Bond Brand Fire-Shield Shaftliner XP.
 - 4) USG Corporation; Sheetrock Brand Mold Tough Gypsum Liner Panel.
- D. Non-Load-Bearing Steel Framing, General: Complying with ASTM C645 requirements for metal unless otherwise indicated and complying with requirements for fire-resistance-rated assembly indicated.
 - 1. Protective Coating: ASTM A653/A653M, G40 (Z120), hot-dip galvanized unless otherwise indicated.
- E. Studs: Manufacturer standard profile for repetitive, corner, and end members as follows:
 - 1. Depth: As indicated on Drawings.
 - 2. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm).
- F. Runner Tracks: Manufacturer standard J-profile track with manufacturer standard long-leg length, but at least 2 inches (51 mm) long and matching studs in depth.
 - 1. Minimum Base-Metal Thickness: Matching steel studs.
- G. 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, provide one of the following:

- a. ClarkDietrich Building Systems; The System by Metal-Lite, Inc.
- b. Fire Trak Corp.; Fire Trak.

H. Elevator-Hoistway-Entrance Struts: Manufacturer standard J-profile jamb strut with long-leg length of 3 inches (76 mm), matching studs in depth, and not less than 0.033 inch (0.84 mm) thick.

I. Finish Panels: Gypsum board as specified in Section 09 29 00 "Gypsum Board."

J. Sound Attenuation Blankets: As specified in Section 09 29 00 "Gypsum Board."

2.3 AUXILIARY MATERIALS

A. Provide auxiliary materials that comply with shaft wall manufacturer written instructions.

B. Trim Accessories: Cornerbead, edge trim, and control joints of material and shapes as specified in Section 09 29 00 "Gypsum Board" that comply with gypsum board shaft wall assembly manufacturer written instructions for application indicated.

C. Steel Drill Screws: ASTM C1002 unless otherwise indicated.

D. Track Fasteners: Power-driven fasteners of size and material required to withstand loading conditions imposed on shaft wall assemblies without exceeding allowable design stress of track, fasteners, or structural substrates in which anchors are embedded.

- 1. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E488/E488M conducted by a qualified testing agency.
- 2. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E1190 conducted by a qualified testing agency.

E. Reinforcing: Galvanized-steel reinforcing strips with 0.033-inch (0.84-mm) minimum thickness of uncoated base metal.

F. Acoustical Sealant: Section 07 92 00 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

- B. Examine panels before installation. Reject panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Sprayed Fire-Resistive Materials: Coordinate with gypsum board shaft wall assemblies so both elements of Work remain complete and undamaged. Patch or replace sprayed fire-resistive materials removed or damaged during installation of shaft wall assemblies to comply with requirements specified in Section 07 81 00 "Applied Fire Protection."
- B. After sprayed fire-resistive materials are applied, remove only to extent necessary for installation of gypsum board shaft wall assemblies and without reducing the fire-resistive material thickness below that which is required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

3.3 INSTALLATION

- A. General: Install gypsum board shaft wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated and manufacturer written installation instructions.
- B. Do not bridge building expansion joints with shaft wall assemblies; frame both sides of expansion joints with furring and other support.
- C. Install supplementary framing in gypsum board shaft wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, wall-mounted door stops, and similar items that cannot be supported directly by shaft wall assembly framing.
 - 1. Elevator Hoistway: At elevator hoistway-entrance door frames, provide jamb struts on each side of door frame.
 - 2. Reinforcing: Provide where items attach directly to shaft wall assembly shown on Drawings; accurately position and secure behind at least one layer of face panel.
- D. Penetrations: At penetrations in shaft wall, maintain fire-resistance rating of shaft wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices, elevator call buttons and floor indicators, and similar items.
- E. Isolate perimeter of gypsum panels from building structure to prevent cracking of panels while maintaining continuity of fire-rated construction.
- F. Firestop Tracks: Install to maintain continuity of fire-resistance-rated assembly indicated.
- G. Control Joints: Install control joints at locations indicated on Drawings while maintaining fire-resistance rating of gypsum board shaft wall assemblies.
- H. Sound-Rated Shaft Wall Assemblies: Seal gypsum board shaft walls with acoustical sealant at perimeter of each assembly where it abuts other work and at joints and penetrations within each assembly.

- I. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

3.4 PROTECTION

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

END OF SECTION

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SECTION 09 22 16

NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Non-load-bearing steel framing systems for interior partitions.
2. Suspension systems for interior ceilings and soffits.
3. Grid suspension systems for gypsum board ceilings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

- ###### A. Product Certificates: For each type of code-compliance certification for studs and tracks.
- ###### B. Evaluation Reports: For embossed, high-strength steel studs and tracks and firestop tracks, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- ###### A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E119 by an independent testing agency.
- ###### B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

2.2 FRAMING SYSTEMS

- ###### A. Framing Members, General: Comply with ASTM C754 for conditions indicated.
1. Steel Sheet Components: Comply with ASTM C645 requirements for steel unless otherwise indicated.
 2. Protective Coating: ASTM A653/A653M, G40 (Z120), hot-dip galvanized unless otherwise indicated.

- B. Studs and Tracks: ASTM C645. Use either conventional steel studs and tracks or embossed, high-strength steel studs and tracks.
1. Steel Studs and Tracks:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) California Expanded Metal Products Company, CEMCO.
 - 2) ClarkDietrich Building Systems.
 - 3) MarinoWARE.
 - 4) Phillips Manufacturing Company.
 - 5) Telling Industries, LLC.
 - b. Minimum Base-Steel Thickness: 0.0329 inch (0.836 mm).
 - c. Depth: See Drawings.
 2. Embossed, High Strength Steel Studs and Tracks: Roll-formed and embossed with surface deformations to stiffen the framing members so that they are structurally comparable to conventional ASTM C645 steel studs and tracks.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) ClarkDietrich; ProSTUD Drywall Framing.
 - 2) MarinoWARE; ViperStud Drywall Framing.
 - b. Minimum Base-Steel Thickness: 0.0190 inch (0.483 mm).
 - c. Depth: See Drawings.
- C. Slip-Type Head Joints: Provide one of the following:
1. Single Long-Leg Track System: ASTM C645 top track with 2-inch- (51-mm-) deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top track and with continuous bridging located within 12 inches (305 mm) of the top of studs to provide lateral bracing.
 2. Double-Track System: ASTM C645 top outer tracks, inside track with 2-inch- (51-mm-) deep flanges in thickness not less than indicated for studs and fastened to studs, and outer track sized to friction-fit over inner track.
 3. Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) Dietrich Metal Framing; SLP-TRK Slotted Deflection Track.
 - 2) Superior Metal Trim; Superior Flex Track System, SFT.
- D. Firestop Tracks: Top track manufactured to allow partition heads to expand and contract with movement of structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Fire Trak Corp.; Fire Trak System attached to studs with Fire Trak Posi Klip.

- 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-Steel Thickness: 0.0329 inch (0.836 mm).
- F. Cold-Rolled Channel Bridging: Steel, 0.0538-inch (1.367-mm) minimum base-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges.
 - 1. Depth: 1-1/2 inches (38 mm).
 - 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (38 by 38 mm), 0.068-inch- (1.72-mm-) thick, galvanized steel.
- G. Hat-Shaped, Rigid Furring Channels: ASTM C645.
 - 1. Minimum Base-Steel Thickness: 0.0329 inch (0.836 mm).
 - 2. Depth: See Drawings.
- H. Resilient Furring Channels: 1/2-inch- (13-mm-) deep, steel sheet members designed to reduce sound transmission.
 - 1. Configuration: Asymmetrical or hat shaped.
- I. Cold-Rolled Furring Channels: 0.053-inch (1.34-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges.
 - 1. Depth: As indicated on Drawings.
 - 2. Furring Brackets: Adjustable, corrugated-edge-type steel sheet with minimum uncoated-steel thickness of 0.0329 inch (0.8 mm).
 - 3. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.
- J. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (32 mm), wall attachment flange of 7/8 inch (22 mm), minimum uncoated-steel thickness of 0.0179 inch (0.455 mm), and depth required to fit insulation thickness indicated.

2.3 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.
- B. Hanger Attachments to Concrete:
 - 1. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01, AC193, AC58, or AC308 as appropriate for the substrate.
 - a. Uses: Securing hangers to structure.
 - b. Type: Torque-controlled, expansion anchor, torque-controlled, adhesive anchor, or adhesive anchor.
 - c. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941/1941M, Class Fe/Zn 5, unless otherwise indicated.

2. Power-Actuated Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
 - C. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.16 inch (4.12 mm) in diameter.
 - D. Flat Hangers: Steel sheet, in size indicated on Drawings.
 - E. Carrying Channels, Main Runners: Cold-rolled, commercial-steel sheet with a base-steel thickness of 0.0538 inch (1.367 mm) and minimum 1/2-inch- (13-mm-) wide flanges.
 1. Depth: See Drawings.
 - F. Furring Channels/Furring Members:
 1. Cold-Rolled Channels: 0.0538-inch (1.367-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges, 3/4 inch (19 mm) deep.
 2. Steel Studs and Tracks: ASTM C645.
 - a. Minimum Base-Steel Thickness: 0.0329 inch (0.836 mm).
 - b. Depth: See Drawings.
 3. Embossed, High-Strength Steel Studs and Tracks: ASTM C645.
 - a. Minimum Base-Steel Thickness: 0.0190 inch (0.483 mm).
 - b. Depth: See Drawings.
 4. Hat-Shaped, Rigid Furring Channels: ASTM C645, 7/8 inch (22 mm) deep.
 - a. Minimum Base-Steel Thickness: 0.0329 inch (0.836 mm).
 5. Resilient Furring Channels: 1/2-inch- (13-mm-) deep members designed to reduce sound transmission.
 - a. Configuration: Asymmetrical or hat shaped.
 - G. Grid Suspension System for Gypsum Board Ceilings: ASTM C645, direct-hung system composed of main beams and cross-furring members that interlock.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Armstrong World Industries, Inc.; Drywall Grid Systems.
 - b. Chicago Metallic Corporation; Drywall Grid System.
 - c. USG Drywall Grid.
- 2.4 AUXILIARY MATERIALS
- A. General: Provide auxiliary materials that comply with referenced installation standards.
 1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
 - 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.
- B. Coordination with Sprayed Fire-Resistive Materials:
 - 1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling tracks to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches (610 mm) o.c.
 - 2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that are required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C754.
 - 1. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.
- B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- D. Install bracing at terminations in assemblies.
- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- C. Install studs so flanges within framing system point in same direction.
- D. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.
 - 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
 - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section, for cripple studs, at head and secure to jamb studs.
 - a. Install two studs at each jamb unless otherwise indicated.
 - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (13-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.
 - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
 - 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
 - 4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
 - a. Firestop Track: 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 (150 mm) o.c.
- E. Direct Furring:
 - 1. Screw to framing.
 - 2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.

F. Z-Shaped Furring Members:

1. Erect insulation, specified in Section 07 21 00 "Thermal Insulation," vertically and hold in place with Z-shaped furring members spaced 24 inches (610 mm) 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 (610 mm) 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 (305 mm) from corner and cut insulation to fit.

G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

3.5 INSTALLING CEILING SUSPENSION SYSTEMS

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

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 (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION

SECTION 092400
STUCCO REPLACEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Removal of stucco on existing building.
2. Exterior portland cement plasterwork (stucco) replacement.

B. Related Sections:

1. Section -40100 "Masonry Repair" for repair of masonry under stucco.
2. Section 099726 "Mineral Silicate Coating" for coating on new stucco.

1.2 ACTION SUBMITTALS

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

1. For mortar mixes submit data for pre-bagged or silo packaging.

B. Shop Drawings: Show locations and installation of control and expansion joints including plans, elevations, sections, details of components, and attachments to other work.

C. Quality Assurance Report: Submit a copy of contractor's quality assurance activities including photographs and log indicated below.

D. Samples for Initial Selection: For each type of factory-prepared finish coat indicated.

E. Samples for Verification: For each type of finish coat indicated; 12 by 12 inches, and prepared on rigid backing.

1.3 QUALITY ASSURANCE

A. Mockups: Before plastering, install mockups of at least 100 sq. ft. in surface area to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Install mockups for each type of finish indicated.
2. For interior plasterwork, simulate finished lighting conditions for review of mockups.
3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

- B. Preinstallation Conference: Conduct conference at Project site.
- C. Quality Assurance Program:
 - 1. Maintain a quality assurance program to ensure compliance with specifications.
 - 2. Record air temperatures, relative humidity and surface temperatures of substrates.
 - 3. Provide daily photographs showing the work completed for each layer. Document each application of water during the moist curing process and the number of days between application of overlying coats.
 - 4. Maintain a log illustrating the day for application of each layer of stucco system.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. 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.

1.5 PROJECT CONDITIONS

- A. Comply with ASTM C 926 requirements.
- B. Exterior Plasterwork:
 - 1. Apply and cure plaster to prevent plaster drying out during curing period. Use procedures required by climatic conditions, including moist curing, providing coverings, and providing barriers to deflect sunlight and wind.
 - 2. Apply plaster when ambient temperature is greater than 40 deg F.
 - 3. Protect plaster coats from freezing for not less than 48 hours after set of plaster coat has occurred.
- C. Factory-Prepared Finishes: Comply with manufacturer's written recommendations for environmental conditions for applying finishes.

PART 2 - PRODUCTS

2.1 METAL LATH

- A. Expanded-Metal Lath: ASTM C 847 with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.
 - 1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
 - 2. Diamond-Mesh Lath: Self-furring, 3.4 lb/sq. yd..

2.2 ACCESSORIES

- A. General: Comply with ASTM C 1063 and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.
- B. Metal Accessories:
 - 1. Foundation Weep Screed: Fabricated from hot-dip galvanized-steel sheet, ASTM A 653/A 653M, G60 (Z180) zinc coating.
 - 2. Cornerite: Fabricated from metal lath with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.
 - 3. Cornerbeads: Fabricated from zinc-coated (galvanized) steel.
 - a. Small nose cornerbead with expanded flanges; use unless otherwise indicated.
 - 4. Casing Beads: Fabricated from zinc-coated (galvanized) steel; square-edged style; with expanded flanges.
 - 5. Control Joints: Fabricated from zinc-coated (galvanized) steel; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.
 - 6. Expansion Joints: Fabricated from zinc-coated (galvanized) steel; folded pair of unperforated screeds in M-shaped configuration; with expanded flanges.

2.3 MISCELLANEOUS MATERIALS

- A. Water for Mixing: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.
- B. Bonding Compound: ASTM C 932.
- C. Steel Drill Screws: For metal-to-metal fastening, ASTM C 1002 or ASTM C 954, as required by thickness of metal being fastened; with pan head that is suitable for application; in lengths required to achieve penetration through joined materials of no fewer than three exposed threads.
- D. Fasteners for Attaching Metal Lath to Substrates: Complying with ASTM C 1063.
- E. Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, not less than 0.0475-inch diameter, unless otherwise indicated.

2.4 PLASTER MATERIALS

- A. Portland Cement: ASTM C 150, Type I.
- B. Lime: ASTM C 206, Type S; or ASTM C 207, Type S.
- C. Sand Aggregate: ASTM C 897.

- D. Reinforcing Fiber: Fine filaments for designed for reinforcing stucco: Basis of Design Stucco-Bond by Forta Concrete Fiber or equivalent

2.5 PLASTER MIXES

- A. General: Comply with ASTM C 926 for applications indicated.
- B. Mixing of dry materials on-site is not allowed. Use only pre-bagged mixes or mixes delivered in silos.
- C. Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork as follows:
 - 1. Portland Cement Mixes:
 - a. Scratch Coat: For cementitious material, mix 1 part portland cement and 3/4 to 1-1/2 parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
 - b. Brown Coat: For cementitious material, mix 1 part portland cement and 3/4 to 1-1/2 parts lime. Use 3 to 5 parts aggregate per part of cementitious material,
 - c. Reinforce scratch and brown coat with fiber additive.
- D. Finish-Coat Mixes: Universalputz Fine Historic Mix Plaster/Stucco by Keim
 - 1. Thin wall plaster/stucco/render made of hydraulic lime, white Portland cement and quartz sand (0-0.6mm grains) with mineral fibers and other mineral fillers.
 - 2. Accommodates thermal expansion cycles preventing surface crazing and cracking.
 - 3. Strength and movement characteristics are similar to most historic load-bearing masonry construction.
 - 4. Texture: Match existing as approved by Architect.
 - 5. Compatible with cementitious coating.

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 REMOVAL OF EXISTING STUCCO

- A. Carefully remove existing stucco without damage to the outer surface of underlying brick. Use hand tools to pry stucco from brick. Do not use power chisels or other means that damage the underlying brick.

3.3 PREPARATION

- A. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.
- B. Provide tarps over scaffolding to eliminate direct sunlight and to reduce wind on stucco as it is applied and while curing. Do not remove tarps until all 3 coats of the stucco is properly cured.
- C. Prepare solid substrates for plaster that are smooth or that do not have the suction capability required to bond with plaster according to ASTM C 926.

3.4 INSTALLING METAL LATH

- A. Expanded-Metal Lath: Install according to ASTM C 1063.

3.5 INSTALLING ACCESSORIES

- A. Install according to ASTM C 1063 and at locations indicated on Drawings.
- B. Reinforcement for External Corners:
 - 1. Install cornerbead.
- C. Control Joints: Install control joints in specific locations approved by Architect for visual effect as follows:
 - 1. As required to delineate plasterwork into areas (panels) of the following maximum sizes:
 - a. Vertical Surfaces: 144 sq. ft..
 - b. Horizontal and other Nonvertical Surfaces: 100 sq. ft..
 - 2. At distances between control joints of not greater than 18 feet o.c.
 - 3. As required to delineate plasterwork into areas (panels) with length-to-width ratios of not greater than 2-1/2:1.
 - 4. Where control joints occur in surface of construction directly behind plaster.
 - 5. Where plasterwork areas change dimensions, to delineate rectangular-shaped areas (panels) and to relieve the stress that occurs at the corner formed by the dimension change.

3.6 PLASTER APPLICATION

- A. General: Comply with ASTM C 926.
 - 1. Do not deviate more than plus or minus 1/4 inch in 10 feet from a true plane in finished plaster surfaces, as measured by a 10-foot straightedge placed on surface.
 - 2. Finish plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, cut base coat free from metal frame before plaster sets and groove finish coat at junctures with metal.
- B. Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork 3/4-inch thickness.
 - 1. Portland cement mixes.
- C. Base Coat Curing:
 - 1. Cure scratch coat by misting or fogging with water at the beginning and end of each day for 3 consecutive days minimum. If it is longer than 3 days until brown coat is applied, mist or fog at the beginning and the end of each day. Misting or fogging shall occur over week ends and holidays without interruption.
 - 2. Cure brown coat by misting or fogging with water at the beginning and end of each day for 2 consecutive days minimum.
 - 3. Cure base coats for 7 days minimum before applying finish coat.
 - 4. Misting or fogging shall occur over weekends and holidays without interruption.
 - 5. Avoid over-saturating the plaster or damaging with a heavy stream of water. Do not use cold water applied to hot stucco.
- D. Finish Coatings: Apply coating system, including primers, finish coats, and sealing topcoats, according to manufacturer's written instructions. Cure per manufacturer's written instructions.

3.7 PLASTER REPAIRS

- A. Repair or replace work to eliminate cracks, dents, blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.

3.8 PROTECTION

- A. Remove temporary protection and enclosure of other work. Promptly remove plaster from door frames, windows, and other surfaces not indicated to be plastered. Repair floors, walls, and other surfaces stained, marred, or otherwise damaged during plastering.

END OF SECTION 092400

SECTION 09 29 00

GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Tile backing panels.
3. Ballistic panels.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For the following products:

1. Trim Accessories: Full-size Sample in 12-inch- (300-mm-) long length for each trim accessory indicated.

C. Samples for Verification: For the following products:

1. Trim Accessories: Full-size Sample in 12-inch- (300-mm-) long length for each trim accessory indicated.

1.3 DELIVERY, STORAGE AND HANDLING

- A.** Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.4 FIELD CONDITIONS

- A.** Environmental Limitations: Comply with ASTM C840 requirements or gypsum board manufacturer written instructions, whichever are more stringent.
- B.** Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
- C.** Do not install panels that are wet, moisture damaged, and mold damaged.
1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.
- C. Ballistic Panels: For ballistic panels, provide materials complying with UL752.

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. Subject to compliance with requirements, provide products by one of the following:
 - 1. USG Corporation.
 - 2. Georgia-Pacific Gypsum LLC.
 - 3. Lafarge North America Inc.
 - 4. National Gypsum Company.
- B. Gypsum Board, Type X: ASTM C1396/C1396M.
 - 1. Thickness: 5/8 inch (15.9 mm).
 - 2. Long Edges: Tapered.
- C. Gypsum Ceiling Board: ASTM C1396/C1396M.
 - 1. Thickness: 1/2 inch (12.7 mm).
 - 2. Long Edges: Tapered.
- D. Mold-Resistant Gypsum Board: ASTM C1396/C1396M. With moisture- and mold-resistant core and paper surfaces.
 - 1. Core: 5/8 inch (15.9 mm), Type X.
 - 2. Long Edges: Tapered.
 - 3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.4 SPECIALTY GYPSUM BOARD

- A. Acoustically Enhanced Gypsum Board: ASTM C1396/C1396M. Multilayer products constructed of two layers of gypsum boards sandwiching a viscoelastic sound-absorbing polymer core.
1. Core: 5/8 inch (15.9 mm), Type X.
 2. Long Edges: Tapered.

2.5 TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A118.9 and ASTM C1288 or ASTM C1325, with manufacturer standard edges.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; FiberCement BackerBoard.
 - b. Custom Building Products; EasyBoard.
 - c. James Hardie Building Products, Inc.; Hardiebacker 500.
 - d. National Gypsum Company, PermaBase Cement Board.
 - e. USG Corporation; DUROCK Cement Board.
 2. Thickness: 5/8 inch (15.9 mm).
 3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.6 BALLISTIC PANELS

- A. Bullet Resistant Fiberglass Panels: Multiple layers of woven roving ballistic grade fiberglass cloth impregnated with a thermoset polyester resin and compressed into flat rigid sheets.
1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. ArmorCore.
 - b. Armortex, Inc.
 - c. C.R. Laurence Co., Inc.
 2. Panels: 7/16 inch nominal thickness, and 4.8 lbs. per sq. ft. nominal weight.
 3. Bullet Resistance: Level 3 in accordance with UL752.
 4. Fasteners: As recommended by manufacturer.

2.7 TRIM ACCESSORIES

- A. Interior Trim: ASTM C1047.
1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet.
 2. Shapes:
 - a. Cornerbead.
 - b. Bullnose bead.
 - c. LC-Bead: J-shaped; exposed long flange receives joint compound.

- d. L-Bead: L-shaped; exposed long flange receives joint compound.
- e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
- f. Expansion/control joint.
- g. Curved-Edge Cornerbead: With notched or flexible flanges.

2.8 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C475/C475M.
- B. Joint Tape:
 - 1. Interior Gypsum Board: Paper.
 - 2. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
 - 1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
 - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 - 3. Fill Coat: For second coat, use setting-type, sandable topping compound.
 - 4. Finish Coat: For third coat, use setting-type, sandable topping compound.
- D. Joint Compound for Tile Backing Panels:
 - 1. Cementitious Backer Units: As recommended by backer unit manufacturer.

2.9 AUXILIARY MATERIALS

- A. Provide auxiliary materials that comply with referenced installation standards and manufacturer written instructions.
- B. Steel Drill Screws: ASTM C1002 unless otherwise indicated.
 - 1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
 - 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- C. Sound-Attenuation Blankets: ASTM C665, Type I blankets, without membrane facing, produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 - 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
- D. Thermal Insulation: As specified in Section 07 21 00 "Thermal Insulation."
- E. Vapor Retarder: As specified in Section 07 26 00 "Vapor Retarders."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION AND FINISHING OF PANELS, GENERAL

- A. Comply with ASTM C840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces, above ceilings, etc., except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- (6.4- to 9.5-mm-) wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open, unsupported edges of stud flanges first.
- I. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both

faces of partitions at perimeters and through penetrations. Comply with ASTM C919 and with manufacturer written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

- J. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 INSTALLATION OF INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:

- 1. Type X: Vertical surfaces unless otherwise indicated.
- 2. Ceiling Type: Ceiling surfaces.

- B. Single-Layer Application:

- 1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
- 2. On partitions/walls, apply gypsum panels vertically, parallel to framing unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 - b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
- 3. On Z-shaped furring members, apply gypsum panels vertically, parallel to framing with no end joints. Locate edge joints over furring members.
- 4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

- C. Multilayer Application:

- 1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches (400 mm) minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
- 2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically, parallel to framing, with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
- 3. On Z-shaped furring members, apply base layer vertically, parallel to framing, and face layer either vertically, parallel to framing or horizontally, perpendicular to framing with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
- 4. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

3.4 INSTALLATION OF TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A108.11, at locations indicated to receive tile.

B. Interior Tile Installation, General:

1. Installation Tolerances: Construct substrates for tile installations with tolerances in compliance with TCNA requirements.
 - a. Large Format Tiles: Provide substrate tolerance of maximum 1/8 inch in 10 feet.
 - b. Large Thin Porcelain Tiles: Provide substrate tolerance of maximum 1/8 inch in 10 feet.
- C. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.5 INSTALLATION OF TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer written instructions.
- B. Control Joints: Install control joints at locations shown on Drawings.
- C. Interior Trim: Install in the following locations:
 1. Cornerbead: Use at outside corners unless otherwise indicated.
 2. Bullnose Bead: Use where indicated.
 3. LC-Bead: Use at exposed panel edges.
 4. L-Bead: Use where indicated.
 5. U-Bead: Use where indicated.
 6. Curved-Edge Cornerbead: Use at curved openings.

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 for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C840:
 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 2. Level 2: Panels that are substrate for tile.
 3. Level 3: See Drawings.
 4. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
 - a. Primer and its application to surfaces are specified in Section 09 90 00 "Painting and Coatings."
 5. Level 5: See Drawings.

- a. Primer and its application to surfaces are specified in Section 09 90 00 "Painting and Coatings."

- E. Cementitious Backer Units: Finish according to manufacturer written instructions.

3.7 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION

NOT FOR BID

SECTION 09 30 00

TILING

PART 1 - GENERAL

1.1 SUMMARY

A. Work Results:

1. Floor and wall tiling.

B. Principal Products:

1. Porcelain tile.
2. Stone thresholds.
3. Waterproofing membrane.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting Attendees and Procedures:

1. Conduct meeting one week, minimum, before starting Work of this Section.
2. Floor Tile on Concrete: Conduct meeting before pouring concrete slabs.
3. Interior Wall Tile: Conduct meeting before installing wall studs.
4. Additional Attendees:
 - a. Concrete installer.
 - b. Gypsum wallboard installer.
5. Additional Agenda Items:
 - a. Preparing and testing concrete slabs for tile installation.
 - b. Locating substrate expansion and movement joints.
 - c. Scheduling waterproof membrane cure times and testing.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Tile and tile trim.
2. Mortar.
3. Grout.
 - a. Provide initial selection color charts or Samples.
4. Membranes.
5. Metal trim.

B. Shop Drawings.

1. Locations of tile and tile patterns.
2. Locations of control and expansion joints.
3. Show field verified dimensions of disruptions in floor and wall surfaces; outlets, controls, vents, drains, switches, and other work results not covered by tile.

C. Samples:

1. Tile: Full sized Samples of each type and color.
2. Metal Trim: 12 inch long section of each profile.
3. Stone thresholds: 12 inch long section by full width.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Tile Subcontractor: Five-Star member of the National Tile Contractors Association.
2. Contractor Supervisor: International Masonry Institute Foreman Certification.
3. Individual Installers: Completed the International Masonry Institute Advanced Certification for Tile Installers, ACT, certification for installation of membranes and large format tile.

B. Field Samples: Construct floor tile installation and wall tile installation, 48 by 48 inches, minimum size; each tile type.

1. Approved Samples establish work results standard.
2. Remove Samples when Architect directs.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements:

1. Store tile and cementitious materials indoors, elevated above grade.
2. Prevent liquid materials from freezing.

1.6 FIELD CONDITIONS

A. Ambient Conditions: Perform Work within following limitations.

1. Building enclosed and environmental systems maintaining design conditions for Owner occupancy.

PART 2 - PRODUCTS

2.1 TILE PRODUCTS

A. Porcelain Tile for Floors and Walls: ANSI A137.1.

1. Manufacturers and Products: See Finish Legend on Drawings.

2. Mounting: Manufacturer standard back mounted tile assemblies.
3. Grout Color: Architect selected.

2.2 TRIM AND ACCESSORIES

- A. Trim Units: Coordinated with colors, sizes, and coursing of adjoining flat tile.
- B. Shapes: See Finish Legend on Drawings.
- C. Stone Thresholds:
 1. Profile: Beveled edges at 1:2 slope with lower edge of bevel aligned with adjacent floor finish.
 - a. Height: 1/2 inch maximum above adjacent floor finish.
 2. Manufacturers and Products: See Finish Legend on Drawings.
 3. Marble Thresholds: ASTM C503, with a minimum abrasion resistance of 12 per ASTM C1353 or ASTM C241 and with honed finish.
 - a. Color and Pattern: Architect selected.

2.3 METAL TRIM

- A. Metal Strips: Transitions.
 1. Manufacturers:
 - a. Blanke Corporation.
 - b. Ceramic Tool Company.
 - c. Schluter Systems.
 2. Shapes: Architect selected.
 3. Height: Align exposed surfaces with tile and setting bed thickness.
 4. Material: Stainless steel.
 5. Finish: Architect selected.

2.4 MORTAR MATERIALS

- A. Improved Modified Dry-Set Cement Mortar: ANSI A118.15.
 1. Manufacturers and Products:
 - a. ARDEX X 3 Plus.
 - b. Custom Building Products MegaLite.
 - c. LATICRETE MULTIMAX LITE.
 - d. MAPEI Keraflex Super.
 - e. Merkrete 735 Dustless Premium Flex.
 - f. Sika Tile 350 Flex Set.
 - g. Or approved equal.

2.5 GROUT MATERIALS

A. Source Limitations:

1. Provide mortar and grout from single manufacturer.

B. Grout, General:

1. Sanded Grout: Joints over 1/8 inch wide.
2. Unsanded Grout: Joints 1/8 inch and less.

C. 100 Percent Solids Epoxy Grout: ANSI A118.3.

1. Manufacturers and Products:

- a. ARDEX WA.
- b. Custom Building Products CEG Lite.
- c. LATICRETE SPECTRALOCK PRO PREMIUM.
- d. MAPEI Kerapoxy CQ.
- e. Merkrete Pro Epoxy.
- f. Sika Tile 825 Epoxy Grout & Mortar.
- g. Or approved equal.

2. Color: Architect selected.

2.6 MEMBRANES

A. Waterproofing Membranes:

1. Fluid Applied Waterproofing Membrane: ANSI A118.10, unreinforced latex rubber or elastomeric polymer.

a. Manufacturers and Products:

- 1) Custom Building Products RedGuard.
- 2) Ardex S1-K.
- 3) LATICRETE HYDRO BAN.
- 4) MAPEI Mapelastic Aqua Defense.
- 5) Merkrete Hydro Guard SP1 Waterproof Membrane.
- 6) SikaTile 100 Moisture Guard.

2. Sheet Waterproofing Membrane: ANSI A118.10, chlorinated polyethylene sheet.

a. Manufacturers and Products:

- 1) Noble Company NobleSeal CIS.

3. Sheet Waterproofing Membrane: ANSI A118.10, reinforced polyethylene sheet.

a. Manufacturers and Products:

- 1) Custom Building Products RedGuard Fabric Membrane.
- 2) LATICRETE HYDRO BAN Sheet Membrane.

- 3) MAPEI Mapeguard CI with MAPEI SM Primer.
- 4) Schluter Systems KERDI.
- 5) SCHONOX AB.

- B. Accessory Products: Membrane manufacturer primers, adhesives, reinforcing strips, transition mesh, joint sealants, and other products required for a complete installation.

2.7 MISCELLANEOUS MATERIALS

- A. Vapor Retarders:

1. Polyethylene: ASTM D4397, 6 mil thickness.

- B. Metal Lath: ASTM C847 expanded flat mesh, 2.5 lb per sq yd, minimum.

2.8 SEALANTS

- A. Joint Sealants: See Section 07 92 00.

1. Color: Architect Selected.

2.9 PERFORMANCE

- A. Dynamic Coefficient of Friction: Tested per ANSI A137.1 DCOF AcuTest.

1. Level Floor Surfaces: 0.42 minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that substrates are ready to receive tile Work, are firm, dry, clean, free of incompatible coatings, and follow ANSI A108.01.

3.2 PREPARATION

- A. Concrete Substrates: Section 09 05 61.

3.3 TILE INSTALLATION

- A. General: Install tile and grout per ANSI A108.1 through ANSI A108.10 requirements and TCNA Handbook recommendations.

1. Install edge strips.

- B. Waterproofing Membranes: Install per ANSI A108.13. Test waterproofing membrane for watertightness before installing tile.
 - 1. Verify that liquid-applied waterproofing membranes have 20 mil dry film thickness, minimum.
- C. Lay out tile to minimize pieces less than half size. Locate cuts to be inconspicuous.
- D. Lay tile to patterns shown on Drawings. Do not interrupt tile pattern through openings.
- E. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor, base and wall joints.
- F. Place tile with joints uniform in width, subject to variance in tolerance allowed in tile size. Make joints watertight, without voids, cracks, excess mortar, or excess grout.
- G. Joint Widths: Manufacturer recommended minimums, and as follows:
 - 1. Porcelain Tile: 1/4 inch.
- H. Form internal angles coved and external angles bullnosed.
- I. Sound tile after setting. Replace hollow sounding units.
- J. Movement Joints: TCNA Method EJ-171. Provide at following locations:
 - 1. Changes in backup material.
 - 2. Changes in plane.
 - 3. Over substrate joints.
 - 4. Interior Locations: 24 feet on center, maximum except 8 feet on center, maximum at direct sunlight exposed surfaces.
- K. Install joint backing and joint sealer per Section 07 92 00.
- L. Stone Thresholds: Install in same setting material as adjacent floor.
- M. Metal Edge Strips: Install where shown on Drawings.
- N. Apply sealant to junction of tile and dissimilar materials and junction of dissimilar planes per Section 07 92 00.

3.4 CLEANING

- A. Cleaning: Clean tile and grout surfaces. Remove grout residue, smears and haze.
- B. Protect tile with kraft paper or other covering to prevent damage and wear. Prohibit foot and wheeled traffic for seven days, minimum, after grouting.

3.5 INSTALLATION SCHEDULE - INTERIOR FLOOR TILE

- A. Floors over Concrete, Thinset: Installation Method TCNA F122.
 - 1. Membrane: Chlorinated polyethylene.
 - 2. Bond Coat: Improved Modified dry-set cement mortar.
 - 3. Grout: 100 percent solids epoxy grout.
- B. Floors over Cracked Concrete, Thinset: Installation Method TCNA F125.
 - 1. Membrane: Full coverage, Chlorinated polyethylene.
 - 2. Bond Coat: Improved Modified dry-set cement mortar.
 - 3. Grout: 100 percent solids epoxy grout.

3.6 INSTALLATION SCHEDULE - INTERIOR WALL TILE

- A. Walls over Concrete or Masonry, Unbonded Mortar Bed: Installation Method TCNA W221 with waterproof membrane.
 - 1. Membrane: Chlorinated polyethylene.
 - 2. Bond Coat: Improved Modified dry-set cement mortar.
 - 3. Grout: 100 percent solids epoxy grout.
- B. Walls over Cementitious Backer Board on Metal Studs, Thinset: Installation Method TCNA W244C.
 - 1. Membrane: Chlorinated polyethylene.
 - 2. Bond Coat: Improved Modified dry-set cement mortar.
 - 3. Grout: 100 percent solids epoxy grout.

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SECTION 09 51 00
ACOUSTICAL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Acoustical aluminum batten system.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of products.
- B. Shop Drawings:
 - 1. Layout of batten system, include dimensions and attachment details.
- C. Samples:
 - 1. Aluminum Batten: 24 inches long Sample of 8 inch depth showing finish.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Manufacturer Test Reports: For acoustical data.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials according to manufacturer instructions.

1.6 FIELD CONDITIONS

- A. Ambient Conditions: Perform work within following limitations:
 - 1. Building enclosed and environmental systems maintaining design conditions for Owner occupancy.
 - 2. Finish work in spaces, including painting, is complete and dry.

- B. Existing Conditions: Verify field measurements before fabrication. Show field measurements on Shop Drawings.

1.7 WARRANTY

- A. Finish Warranty: Manufacturer agrees to repair or replace components that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Warranty Period: 15 years.

PART 2 - PRODUCTS

2.1 ACOUSTICAL ALUMINUM BATTEN SYSTEM

- A. Aluminum batten system: Two piece, hidden fastener, extruded aluminum batten for interior ceiling application.
 - 1. Manufacturer and Product: Longboard Architectural Products Inc., 8 Inch Link & Lock Batten, as basis of design.
 - a. Finish: See Finish Legend on Drawings.
 - b. Fasteners: Manufacturer recommended.
 - c. Components: Manufacturer standard end caps, mounting clips, and isolation washers.
 - 2. Performance:
 - a. Fire Rating: ASTM E136 and ASTM E84, Class A.
 - b. Weather resistant.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with manufacturer requirements.

3.2 PREPARATION

- A. Ceiling substrates to be painted and dried prior to installation of batten system.

3.3 INSTALLATION

- A. Aluminum Batten System: Comply with manufacturer written instructions.

3.4 CLEANING

- A. Clean surfaces to remove evidence of soiling.
- B. Repair or replace damaged work surfaces to acceptable conditions.

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SECTION 09 51 13

ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Acoustical panels and exposed suspension systems for interior ceilings.

- B.** Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.2 PREINSTALLATION MEETINGS

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

1.3 ACTION SUBMITTALS

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

- B.** Samples: For each exposed product and for each color and texture specified, 6 inches (150 mm) in size.

- C.** Samples for Initial Selection: For components with factory-applied finishes.

- D.** Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of sizes indicated below:

1. Acoustical Panels: Set of 6-inch- (150-mm-) square Samples of each type, color, pattern, and texture.
2. Exposed Suspension-System Members, Moldings, and Trim: Set of 6-inch- (150-mm-) long Samples of each type, finish, and color.
3. Concealed or Exposed Reveal Type Suspension-System Members, Moldings, and Trim: Set of 6-inch- (150-mm-) long Samples of each type, finish, and color.
4. Clips: Full-size each type of clips.

- E.** Delegated-Design Submittal: For seismic restraints for ceiling systems.

1. Include design calculations for seismic restraints including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Ceiling suspension-system members.
 2. Structural members to which suspension systems will be attached.
 3. Method of attaching hangers to building structure.
 - a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.
 4. Carrying channels or other supplemental support for hanger-wire attachment where conditions do not permit installation of hanger wires at required spacing.
 5. Size and location of initial access modules for acoustical panels.
 6. Items penetrating finished ceiling and ceiling-mounted items including the following:
 - a. Lighting fixtures.
 - b. Diffusers.
 - c. Grilles.
 - d. Speakers.
 - e. Sprinklers.
 - f. Access panels.
 - g. Perimeter moldings.
 7. Show operation of hinged and sliding components covered by or adjacent to acoustical panels.
 8. Minimum Drawing Scale: 1/4 inch = 1 foot (1:48).
- 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.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For finishes to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Acoustical Ceiling Units: Full-size panels equal to 2 percent of quantity installed.
 2. Suspension-System Components: Quantity of each exposed component equal to 2 percent of quantity installed.
 3. Hold-Down Clips: Equal to 2 percent of quantity installed.

4. Impact Clips: Equal to 2 percent of quantity installed.

1.7 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 1. Build mockup of typical ceiling area as 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. Deliver acoustical panels, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
 1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of acoustical ceiling panel and its supporting suspension system from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design seismic restraints for ceiling systems.
- B. Seismic Performance: Suspended ceilings shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

- C. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: Class A according to ASTM E1264.
 - 2. Smoke-Developed Index: 450 or less.
- D. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Indicate design designations from UL or from the listings of another qualified testing agency.

2.3 ACOUSTICAL PANELS

- A. Manufacturers and Products: See Finish Legend on Drawings for Basis of Design products, sizes, and colors.
 - 1. Substitution Requests: Substitution Requests require a full sample of the panel to be dropped off at the Architect's office below. See Specification 012500 "Substitution Procedures" for additional information.
 - a. Tevebaugh Architecture
Two Mill Road, Suite 210
Wilmington, DE 19806.
- B. Acoustical Panel Standard: Provide manufacturer standard panels according to ASTM E1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.
- C. Color: See Finish Legend on Drawings.
- D. Edge/Joint Detail: See Finish Legend on Drawings.
- E. Thickness: See Finish Legend on Drawings.
- F. Modular Size: See Finish Legend on Drawings.
- G. Antimicrobial Treatment: Manufacturer standard broad spectrum, 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 D3273, ASTM D3274, or ASTM G21 and evaluated according to ASTM D3274 or ASTM G21.

2.4 METAL SUSPENSION SYSTEM

- A. Manufacturers and Products: See Finish Legend on Drawings for Basis of Design products, sizes, and colors.
 - 1. Substitution Requests: Substitution Requests require a full sample of the tile to be dropped off at the Architect's office below. See Specification 012500 "Substitution Procedures" for additional information.

- a. Tevebaugh Architecture
Two Mill Road, Suite 210
Wilmington, DE 19806.
- B. Metal Suspension-System Standard: Provide manufacturer standard, direct-hung, metal suspension system and accessories according to ASTM C635/C635M and designated by type, structural classification, and finish indicated.
 1. High-Humidity Finish: Provide coating tested and classified for "severe environment performance" according to ASTM C635/C635M.
- C. Provide exposed grid, concealed grid, exposed reveal and other type suspension members as required for the systems listed in the Finish Legend on Drawings.

2.5 ACCESSORIES

- A. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
 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 E488/E488M or ASTM E1512 as applicable, conducted by a qualified testing and inspecting agency.
 - a. Type: Postinstalled expansion and Postinstalled bonded anchors.
 - b. Corrosion Protection: Carbon-steel components zinc plated according to ASTM B633, Class SC 1 mild service condition.
 - c. Corrosion Protection: Stainless-steel components complying with ASTM F593 and ASTM F594, Group 1 Alloy 304 or 316.
 - d. Corrosion Protection: Components fabricated from nickel-copper-alloy rods complying with ASTM B164 for UNS No. N04400 alloy.
 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 ten times that imposed by ceiling construction, as determined by testing according to ASTM E1190, conducted by a qualified testing and inspecting agency.
- B. Wire Hangers, Braces, and Ties: Provide wires as follows:
 1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
 2. Stainless-Steel Wire: ASTM A580/A580M, Type 304, nonmagnetic.
 3. Nickel-Copper-Alloy Wire: ASTM B164, nickel-copper-alloy UNS No. N04400.
 4. Size: Wire diameter sufficient for its stress at three times hanger design load ASTM C635/C635M, Table 1, "Direct Hung" will be less than yield stress of wire, but not less than 0.106-inch- (2.69-mm-) diameter wire.
- C. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.
- D. Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.

- E. Angle Hangers: Angles with legs not less than 7/8 inch (22 mm) wide; formed with 0.04-inch- (1-mm-) thick, galvanized-steel sheet complying with ASTM A653/A653M, G90 (Z275) coating designation; with bolted connections and 5/16-inch- (8-mm-) diameter bolts.
- F. Hold-Down Clips: Manufacturer standard hold-down.
- G. Impact Clips: Manufacturer standard impact-clip system designed to absorb impact forces against acoustical panels.

2.6 METAL EDGE MOLDINGS AND TRIM

- A. Manufacturers and Products: See Finish Schedule on Drawings.
- B. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
 - 1. Edge moldings shall fit acoustical panel edge details and suspension systems indicated and match width and configuration of exposed runners unless otherwise indicated.
 - 2. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
 - 3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
- C. Extruded-Aluminum Edge Moldings and Trim: Provide manufacturer extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements.
 - 1. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of 1.5 mils (0.04 mm). Comply with ASTM C635/C635M and coating manufacturer written instructions for cleaning, conversion coating, and applying and baking finish.

2.7 ACOUSTICAL

- A. Acoustical Blanket: Type and thickness called out on Drawings. See Section 09 29 00 "Gypsum Board."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.

- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.
- B. Layout openings for penetrations centered on the penetrating items.

3.3 INSTALLATION

- A. Install acoustical panel ceilings according to ASTM C636/C636M and manufacturer written instructions.
 - 1. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.
- B. Suspend ceiling hangers from building's structural members and as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 - 2. Splay hangers only where required 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 to structure or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 - 5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
 - 6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 - 7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 - 8. Do not attach hangers to steel deck tabs.
 - 9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 - 10. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.
 - 11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.

- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
 - 1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 - 2. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends. Miter corners accurately and connect securely.
 - 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide precise fit.
 - 1. Arrange directionally patterned acoustical panels as follows:
 - a. See reflected ceiling plans.
 - 2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
 - 3. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
 - 4. For reveal-edged panels on suspension-system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension-system surfaces and panel faces flush with bottom face of runners.
 - 5. 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.
 - 6. Install hold-down and impact clips; space according to panel manufacturer written instructions unless otherwise indicated.
 - a. Hold-Down Clips: Space 24 inches (610 mm) o.c. on all cross runners.
 - 7. Protect lighting fixtures and air ducts according to requirements indicated for fire-resistance-rated assembly.

3.4 ERECTION TOLERANCES

- A. Suspended Ceilings: Install main and cross runners level to a tolerance of 1/8 inch in 12 feet (3 mm in 3.6 m), non-cumulative.
- B. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3 mm in 3.6 m), non-cumulative.

3.5 FIELD QUALITY CONTROL

- A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
 - 1. Periodic inspection during the installation of suspended ceiling grids according to ASCE/SEI 7.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Perform the following tests and inspections of completed installations of acoustical panel ceiling hangers and anchors and fasteners in successive stages and when installation of ceiling suspension systems on each floor has reached 20 percent completion, but no panels have been installed. Do not proceed with installations of acoustical panel ceiling hangers for the next area until test results for previously completed installations of acoustical panel ceiling hangers show compliance with requirements.
 - 1. Within each test area, testing agency will select one of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for 200 lbf (890 N) of tension; it will also select one of every two postinstalled anchors used to attach bracing wires to concrete and will test them for 440 lbf (1957 N) of tension.
 - 2. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.
- D. Acoustical panel ceiling hangers, anchors, and fasteners will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.6 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer written instructions for cleaning and touchup of minor finish damage.
- B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION

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SECTION 09 64 29

WOOD STRIP AND PLANK FLOORING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Solid wood plank flooring.
 - 2. Acoustic underlayment.

1.2 ADMINISTRATION REQUIREMENTS

- A. Preinstallation Meeting:
 - 1. Conduct meeting one week, minimum, before starting Work of this Section.
 - 2. Additional Agenda Item:
 - a. Review installation procedures including procedures for acclimation of flooring materials.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Indicate floor joint pattern and termination details. Indicate provisions for expansion and contraction.
- C. Samples: Manufacturer standard size Samples illustrating floor finish, color, and sheen.

1.4 INFORMATION SUBMITTALS

- A. Qualification Data: For Installer.
- B. Manufacturer instructions.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Submit maintenance procedures, recommended maintenance materials, suggested schedule for cleaning, stripping, and re-finishing, stain removal methods, and recommended polishes and waxes.

1.6 QUALITY ASSURANCE

- A. Perform Work according to NWFA/NOFMA.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 - 1. Build mockups at locations and in sizes as directed by Architect.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- B. Store materials according to manufacturer instructions.
- C. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

1.8 FIELD CONDITIONS

- A. Provide permanent HVAC operation and permanent lighting prior to installation.
- B. Do not install wood flooring until wet construction Work has been complete, ambient air at installation space has moisture content stabilized between 35 and 50 percent, and temperature is stabilized between 65 and 85 degrees F (18 and 27 degrees C).
- C. Maintain room temperature between and humidity according to adhesive and flooring manufacturer instructions for period of two days prior to delivery of materials to installation space, during installation, and continuously after installation.
- D. Acclimation:
 - 1. Do not install wood flooring until wood materials have been acclimated to ambient temperature and humidity conditions for minimum of 72 hours.
 - 2. Stack wood to facilitate acclimation by cross-ventilation of wood materials.

1.9 WARRANTY

- A. Manufacturer standard material warranty.

PART 2 - PRODUCTS

2.1 SOLID WOOD FLOORING

- A. Solid Wood Plank Flooring: Factory finished.
 - 1. Manufacturers and Products:

- a. Baird Brothers Sawmill, Inc., White Oak Hardwood, as basis of design.
- 2. Species: White oak
- 3. Grade: Select grade
- 4. Cut: Quarter sawn end matched
- 5. Edge: T&G 4 edges
- 6. Size: 3/4" Thick, mix of 3", 4" & 5" widths
- 7. Lengths: Random 36" - 96" (none shorter)
- 8. Finish: Sanded
- 9. Stain: Baird "Early American" satin sheen

2.2 ACCESSORIES

- A. Sound Control Underlayment: Rubber mix, resilient layer.
 - 1. Manufacturer and Product: Havwoods Ltd., Stratabase A50 Acoustic Underlay, as basis of design.
- B. Adhesive: Manufacturer recommended.
- C. Thresholds and Saddles: To match wood flooring. Tapered on each side.
- D. Reducer Strips: To match wood flooring. 2 inches wide, tapered, and in thickness required to match height of flooring.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that the substrate is clean, sound and free surface contaminants that will interfere with the bonding of the adhesive.
- B. Verify that the substrate is flat to within 3/16 inch in 10 feet, free from cracks, holes, voids, ridges, projections and other defects impairing performance or appearance.
- C. Verify that wood flooring has been acclimated to ambient temperatures, and that acclimation and ambient temperatures are according to flooring manufacturer recommendations.

3.2 PREPARATION

- A. Broom or vacuum clean substrates to be covered immediately before product installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- A. Follow NWFA Installation Guidelines: Wood Flooring.
- B. Glue down flooring on substrate using manufacturer recommended adhesive.

- C. Provide expansion space at walls and other obstructions and terminations of flooring.
- D. Install in random pattern as indicated on drawings.
- E. Arrange flooring with square ends set flush and tight.
- F. Terminate flooring at centerline of door openings where adjacent floor finish is dissimilar, and install divider strips.

3.4 CLEANING

- A. Clean and polish floor surfaces according to manufacturer instructions.

3.5 PROTECTION

- A. Prohibit traffic for 48 hours after installation.
- B. Protect installed wood flooring during remainder of construction period with covering of heavy kraft paper or other suitable material. Do not use plastic sheet or film that might cause condensation.
 - 1. Do not move heavy and sharp objects directly over kraft-paper-covered wood flooring. Protect flooring with plywood or hardboard panels to prevent damage from storing or moving objects over flooring.

END OF SECTION

SECTION 09 65 13

RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Thermoset-rubber base.
 2. Rubber molding accessories.
 3. Rubber stair accessories.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, not less than 12 inches (300 mm) long.
- C. Samples for Initial Selection: For each type of product indicated.
- D. Samples for Verification: For each type of product indicated and for each color, texture, and pattern required in manufacturer's standard-size Samples, but not less than 12 inches (300 mm) long.
- E. Product Schedule: For resilient base and accessory products. Use same designations indicated on Drawings.

1.3 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Furnish not less than 10 linear feet (3 linear m) for every 500 linear feet (150 linear m) or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.4 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 (10 deg C) or more than 90 deg F (32 deg C).

1.5 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive resilient products during the following periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).
- C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 THERMOSET-RUBBER BASE

- A. Manufacturers and Products: See Finish Legend on Drawings for Basis of Design products, sizes, and colors.
 - 1. Substitution Requests: Substitution Requests require a full sample of the product to be dropped off at the Architect's office below. See Specification 012500 "Substitution Procedures" for additional information.
 - a. Tevebaugh Architecture
Two Mill Road, Suite 210
Wilmington, DE 19806.
- B. Product Standard: ASTM F1861, Type TS (rubber, vulcanized thermoset), Group I (solid, homogeneous).
 - 1. Style and Location:
 - a. Style A, Straight: Provide in areas with carpet.
 - b. Style B, Cove: Provide in areas with resilient floor coverings.
 - c. Other styles where indicated on Drawings.
- C. Thickness: 0.125 inch (3.2 mm).
- D. Height: As indicated on Drawings.
- E. Lengths: Coils in manufacturer's standard length.
- F. Outside Corners: Job formed.
- G. Inside Corners: Job formed.
- H. Colors: See Finish Legend on Drawings.

2.2 RUBBER MOLDING ACCESSORY

- A. Manufacturers and Products: See Finish Legend on Drawings for Basis of Design products, sizes, and colors.
 - 1. Substitution Requests: Substitution Requests require a full sample of the molding to be dropped off at the Architect's office below. See Specification 012500 "Substitution Procedures" for additional information.
 - a. Tevebaugh Architecture
Two Mill Road, Suite 210
Wilmington, DE 19806.
- B. Description: Rubber transition strips.
- C. Locations: Provide rubber molding accessories in areas indicated.
- D. Colors and Patterns: As indicated by manufacturer's designations.

2.3 RUBBER STAIR ACCESSORIES

- A. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
 - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
- B. Manufacturers: Provide from one of the following:
 - 1. Armstrong World Industries, Inc.
 - 2. Johnsonite; A Tarkett Company.
 - 3. Roppe Corporation, USA.
- C. Stair Treads: ASTM F 2169.
 - 1. Type: TP (rubber, thermoplastic).
 - 2. Class: 2 (pattern; embossed, grooved, or ribbed).
 - 3. Group: 2 (with contrasting color for the visually impaired).
 - 4. Nosing Style: Square, adjustable to cover angles between 60 and 90 degrees.
 - 5. Nosing Height: 1-1/2 inches (38 mm).
 - 6. Thickness: 1/4 inch (6 mm) and tapered to back edge.
 - 7. Size: Lengths and depths to fit each stair tread in one piece.
- D. Landing Tile: Matching treads; produced by same manufacturer as treads and recommended by manufacturer for installation with treads.
- E. Locations: Provide rubber stair accessories in areas indicated on Drawings.
- F. Colors and Patterns: Architect selected.

2.4 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.
 - 1. Adhesives shall have a VOC content of 50 g/L or less and 60 g/L or less for rubber stair treads.
- 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.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions and Section 09 05 61, to ensure adhesion of resilient products.
- B. Concrete Substrates for Resilient Stair Accessories: Prepare horizontal surfaces according to ASTM F710.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
 - 3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

- D. Do not install resilient products until materials are the same temperature as space where they are to be installed.
 - 1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.
- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Job-Formed Corners:
 - 1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches (76 mm) 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 (76 mm) in length.
 - a. Miter corners to minimize open joints.

3.4 RESILIENT ACCESSORY INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient accessories.
- B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.
- C. Resilient Stair Accessories:
 - 1. Use stair-tread-nose filler to fill nosing substrates that do not conform to tread contours.
 - 2. Tightly adhere to substrates throughout length of each piece.

3.5 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- B. Perform the following operations immediately after completing resilient-product installation:
 - 1. Remove adhesive and other blemishes from surfaces.
 - 2. Sweep and vacuum horizontal surfaces thoroughly.
 - 3. Damp-mop horizontal surfaces to remove marks and soil.
- C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION

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SECTION 09 65 19
RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rubber floor tile.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For each type of resilient floor tile.

1. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
2. Show details of special patterns.

C. Samples: Full-size units of each color, texture, and pattern of floor tile required.

D. Samples for Initial Selection: For each type of floor tile indicated.

E. Samples for Verification: Full-size units of each color and pattern of floor tile required.

F. Product Schedule: For floor tile. Use same designations indicated on Drawings.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of floor tile to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Floor Tile: Furnish one box for every 50 boxes or fraction thereof, of each type, color, and pattern of floor tile installed.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for floor tile installation and seaming method indicated.
 - 1. Engage an installer who employs workers for this Project who are trained or certified by floor tile manufacturer for installation techniques required.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Coordinate mockups in this Section with mockups specified in other Sections.
 - a. Size: Minimum 100 sq. ft. (9.3 sq. m) 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.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C). Store floor tiles on flat surfaces.

1.8 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive floor tile during the following periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).
- C. Close spaces to traffic during floor tile installation.
- D. Close spaces to traffic for 48 hours after floor tile installation.
- E. Install floor tile after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For resilient floor tile, as determined by testing identical products according to ASTM E648 or NFPA 253 by a qualified testing agency.
 - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

2.2 RUBBER FLOOR TILE

- A. Manufacturers and Products: See Finish Schedule on Drawings for Basis of Design products, sizes, and colors.
 - 1. Substitution Requests: Substitution Requests require a full sample of the tile to be dropped off at the Architect's office below. See Specification 012500 "Substitution Procedures" for additional information.
 - a. Tevebaugh Architecture
Two Mill Road, Suite 210
Wilmington, DE 19806.
- B. Tile Standard: ASTM F1344, Class I-B, Homogeneous Rubber Tile, through mottled.
- C. Hardness: Manufacturer's standard hardness, measured using Shore, Type A durometer according to ASTM D2240.
- D. Thickness: See Drawings.
- E. Size: See Drawings.
- F. Colors and Patterns: See Drawings.

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 indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer written instructions and Section 09 05 61 Common Work Results for Flooring Preparation, to ensure adhesion of resilient products.
- B. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer and per Section 09 05 61 Common Work Results for Flooring Preparation. 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.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install floor tiles until materials are the same temperature as space where they are to be installed.
 - 1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

3.3 FLOOR TILE INSTALLATION

- A. Comply with manufacturer written instructions for installing floor tile.
- B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
 - 1. Lay tiles in pattern indicated.
- C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
 - 1. Lay tiles in pattern of colors and sizes indicated.

- D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.
- G. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.
- H. Adhere floor tiles to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.4 CLEANING AND PROTECTION

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

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SECTION 09 66 23

RESINOUS MATRIX TERRAZZO FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thin-set, epoxy-resin terrazzo flooring.
2. Precast epoxy-resin terrazzo base units.
3. Precast epoxy-resin terrazzo stair tread units.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to terrazzo including, but not limited to, the following:
 - a. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
 - b. Review and finalize construction schedule and verify availability of materials, installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - c. Review special terrazzo designs and patterns.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include terrazzo installation requirements. Include plans, sections, component details, and relationship to other work. Show layout of the following:

1. Divider strips.
2. Control-joint strips.
3. Accessory strips.
4. Abrasive strips.
5. Stair treads, risers, and landings.
6. Precast terrazzo jointing and edge configurations.
7. Terrazzo patterns.
8. Precast terrazzo base.

C. Samples: For each exposed product and for each color and texture specified, 6 inches (150 mm) in size.

D. Samples for Initial Selection: NTMA "Terrazzo Color Palette" showing the full range of colors and patterns available for each terrazzo type.

- E. Samples for Verification: For each type, material, color, and pattern of terrazzo and accessory required showing the full range of color, texture, and pattern variations expected. Label each terrazzo Sample to identify manufacturer matrix color and aggregate types, sizes, and proportions. Prepare Samples of same thickness and from same material to be used for the Work, in sizes indicated below:
1. Terrazzo: 6-inch- (150-mm-) square Samples.
 2. Precast Terrazzo: 6-inch- (150-mm-) square Samples.
 3. Accessories: 6-inch- (150-mm-) long Samples of each exposed strip item required.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Material Certificates: For each type of terrazzo material or product.
- C. Installer Certificates: Signed by manufacturers certifying that installers comply with requirements.
- D. Preinstallation moisture-testing reports.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For terrazzo to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications:
1. Engage an installer who is a contractor member of NTMA.
 2. Engage an installer who is certified in writing by terrazzo manufacturer as qualified to install manufacturer products.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
1. Build mockups for terrazzo including accessories.
 - a. Size: Minimum 100 sq. ft. (9 sq. m) of typical poured-in-place flooring and base condition for each color and pattern in locations directed by Architect.
 - b. Include first three stair treads.
 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 requirements approved mockups may remain as a part of the Work.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in supplier original wrappings and containers, labeled with source or manufacturer name, material or product brand name, and lot number if any.
- B. Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Comply with manufacturer written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting terrazzo installation.
- B. Field Measurements: Verify actual dimensions of construction contiguous with precast terrazzo by field measurements before fabrication.
- C. Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during terrazzo installation.
- D. Close spaces to traffic during terrazzo application and for not less than 24 hours after application unless manufacturer recommends a longer period.
- E. Control and collect water and dust produced by grinding operations. Protect adjacent construction from detrimental effects of grinding operations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain primary terrazzo materials from single source from single manufacturer. Provide secondary materials including patching and fill material, joint sealant, and repair materials of type and from source recommended by manufacturer of primary materials.
- B. Source Limitations for Aggregates: Obtain each color, grade, type, and variety of granular materials from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.2 PERFORMANCE REQUIREMENTS

- A. NTMA Standards: Comply with NTMA written recommendations for terrazzo type indicated unless more stringent requirements are specified.

2.3 EPOXY-RESIN TERRAZZO

- A. Epoxy-Resin Terrazzo: Comply with manufacturer written instructions for matrix and aggregate proportions and mixing.

- B. Manufacturers and Products: See Finish Legend on Drawings for Basis of Design products, sizes, and colors.
1. Substitution Requests: Substitution Requests require a full sample of the flooring to be dropped off at the Architect's office below. See Specification 01 25 00 "Substitution Procedures" for additional information.
- a. Tevebaugh Architecture
Two Mill Road, Suite 210
Wilmington, DE 19806.
- C. Mix Color and Pattern: As selected by Architect from manufacturer full range.
- D. Materials:
1. Moisture-Vapor-Emission-Control Membrane: Two-component, high-solids, high-density, low-odor, epoxy-based membrane-forming product produced by epoxy terrazzo manufacturer that reduces moisture emission from concrete substrate to not more than 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
2. Substrate-Crack-Suppression Membrane: Product of terrazzo-resin manufacturer, having minimum 120 percent elongation potential according to ASTM D412.
- a. Reinforcement: Fiberglass scrim.
3. Primer: Manufacturer product recommended for substrate and use indicated.
4. Epoxy-Resin Matrix: Manufacturer standard recommended for use indicated and in color required for mix indicated.
- a. Physical Properties without Aggregates:
- 1) Hardness: 60 to 85 per ASTM D2240, Shore D.
 - 2) Minimum Tensile Strength: 3000 psi (20.7 MPa) per ASTM D638 for a 2-inch (51-mm) specimen made using a "C" die per ASTM D412.
 - 3) Minimum Compressive Strength: 10,000 psi (6.9 MPa) per ASTM D695, Specimen B cylinder.
 - 4) Chemical Resistance: No deleterious effects by contaminants listed below after seven-day immersion at room temperature per ASTM D1308.
 - a) Distilled water.
 - b) Mineral water.
 - c) Isopropanol.
 - d) Ethanol.
 - e) 0.025 percent detergent solution.
 - f) 1.0 percent soap solution.
 - g) 5 percent acetic acid.
 - h) 10 percent sodium hydroxide.
 - i) 10 percent hydrochloric acid.
 - j) 30 percent sulfuric acid.
- b. Physical Properties with Aggregates: For terrazzo blended according to manufacturer recommendations with one part epoxy resin with three parts marble aggregate consisting of 60 percent No. 1 chips and 40 percent No. 0 chips that is ground and grouted to a 1/4-inch (6.35-mm) nominal thickness, and cured for 7 days at 75 deg F (24 deg C) plus or minus 2 deg F (1 deg C) and at 50 percent plus or minus 2 percent relative humidity.

- 1) Flammability: Self-extinguishing, maximum extent of burning 1/4 inch (6.35 mm) according to ASTM D635.
 - 2) Thermal Coefficient of Linear Expansion: 0.0025 inch/inch per deg F (0.0025 mm/mm per 0.5556 deg C) according to ASTM C531.
5. Aggregates: Comply with NTMA gradation standards for mix indicated and contain no deleterious or foreign matter.
- a. Abrasion and Impact Resistance: Less than 40 percent loss per ASTM C131/C131M.
 - b. 24-Hour Absorption Rate: Less than 0.75 percent.
 - c. Dust Content: Less than 1.0 percent by weight.
6. Finishing Grout: Resin based.

2.4 PRECAST EPOXY-RESIN TERRAZZO

- A. Manufacturers and Products: See Finish Legend on Drawings for Basis of Design products, sizes, and colors.
1. Substitution Requests: Substitution Requests require a full sample of the tile to be dropped off at the Architect's office below. See Specification 012500 "Substitution Procedures" for additional information.
 - a. Tevebaugh Architecture
Two Mill Road, Suite 210
Wilmington, DE 19806.
- B. Precast Terrazzo Base: Minimum 3/8-inch- (10-mm-) thick, epoxy terrazzo units cast in maximum lengths possible, but not less than 36 inches (900 mm). Comply with manufacturer written instructions for fabricating precast terrazzo base units in sizes and profiles indicated.
1. Type: As indicated.
 2. Outside Corner Units: With finished returned edges at outside corner.
 3. Color, Pattern, and Finish: See Finish Legend on Drawings.
- C. Precast Terrazzo Units: Minimum 3/4-inch (19-mm) thick, epoxy terrazzo units. Comply with manufacturer written instructions for fabricating precast units in sizes and profiles indicated. Reinforce units as required by unit sizes, profiles, and thicknesses and as recommended by manufacturer. Finish exposed-to-view edges and reveals to match face finish. Ease exposed edges to 1/8-inch (3.2-mm) radius.
1. Color, Pattern, and Finish: See Finish Legend on Drawings.
- D. Precast Terrazzo Treads:
1. Precast Terrazzo Stair Treads: Epoxy terrazzo units cast with internal steel profile in maximum lengths possible. Comply with manufacturer written instructions for fabricating precast terrazzo units in sizes and profiles indicated.
 - a. Manufacturers: Subject to compliance with requirements, provide one of the following:

- 1) Precast Terrazzo Enterprises, Inc.
 - 2) Romoco Precast Terrazzo Products.
 - 3) Wausau Tile Inc.
- b. Epoxy Resin Matrix: Manufacturer standard recommended for use indicated.
- c. Aggregates: Comply with NTMA gradation standards for mix indicated, and containing no deleterious or foreign matter.
- 1) Abrasion and Impact Resistance: Less than 40 percent loss per ASTM C131/C131M.
 - a) 24-Hour Absorption Rate: Less than 0.75 percent.
 - b) Dust Content: Less than 1.0 percent by weight.
- d. Reinforcement: ASTM A615/A615M, Grade 60 (Grade 420) bars, as required by unit size, profile, and thickness.
- e. Abrasive Inserts: 1/2-inch- (13-mm-) wide, silicon carbon/epoxy mixture.
- 1) Provide three inserts, 1/2 inch (13 mm) apart, with first insert located 1 inch (25 mm) from nosing at adjacent stair riser locations.
- f. Color: Architect selected.
- g. Finish: Honed.
- h. Surface Sealer: Slip- and stain-resistant, penetrating sealer that is chemically neutral with pH factor between 7 and 8; does not affect color or physical properties of terrazzo type indicated; is recommend by sealer manufacturer for use with specified terrazzo; and complies with NTMA guide specification for terrazzo type applicable for this Project.

2.5 STRIP MATERIALS

- A. Thin-Set Divider Strips: L-type angle in depth required for topping thickness indicated.
1. Material: Brass.
 - a. Acceptable Alternative: Aluminum.
 2. Top Width: 1/8 inch or as indicated.
- B. Heavy-Top Divider Strips: L-type angle in depth required for topping thickness indicated.
1. Bottom-Section Material: Matching top-section material.
 2. Top-Section Material: Brass.
 3. Top-Section Width: As indicated.
- C. Control-Joint Strips: Separate, double L-type angles, positioned back to back, that match material and color of divider strips and in depth required for topping thickness indicated.
- D. Accessory Strips: Match divider-strip width, material, and color unless otherwise indicated. Use the following types of accessory strips as required to provide a complete installation:
1. Base-bead strips for exposed top edge of terrazzo base.
 2. Edge-bead strips for exposed edges of terrazzo.

3. Nosings for terrazzo stair treads and landings.

2.6 MISCELLANEOUS ACCESSORIES

A. Anchoring Devices:

1. Strips: Provide mechanical anchoring devices or adhesives for strip materials as recommended by manufacturer and as required for secure attachment to substrate.
2. Precast Terrazzo: Provide mechanical anchoring devices as recommended by fabricator for proper anchorage and support of units for conditions of installation and support.

B. Patching and Fill Material: Terrazzo manufacturer resinous product approved and recommended by manufacturer for application indicated.

C. Joint Compound: Terrazzo manufacturer resinous product approved and recommended by manufacturer for application indicated.

D. Resinous Matrix Terrazzo Cleaner: Chemically neutral cleaner with pH factor between 7 and 10 that is biodegradable, phosphate free, and recommended by sealer manufacturer for use on terrazzo type indicated.

E. Sealer: Slip- and stain-resistant, penetrating-type sealer that is chemically neutral; does not affect terrazzo color or physical properties; and is recommended by sealer manufacturer.

1. Surface Friction: Not less than 0.6 according to ASTM D2047.
2. Acid-Base Properties: With pH factor between 7 and 10.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Clean substrates of substances, including oil, grease, and curing compounds, that might impair terrazzo bond. Provide clean, dry, and neutral substrate for terrazzo application.
- B. Concrete Slabs:
 1. Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with terrazzo.

- a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
 - b. Repair damaged and deteriorated concrete according to terrazzo manufacturer written instructions.
 - c. Use patching and fill material to fill holes and depressions in substrates according to terrazzo manufacturer's written instructions.
- C. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer written instructions.
- D. Preinstallation Moisture Testing:
 1. Testing Agency: Engage a qualified testing agency to perform tests.
 2. Test substrate for moisture per manufacturer instructions and Section 09 05 12 Concrete Floor Moisture Content and pH Testing.
- E. Moisture-Vapor-Emission-Control Membrane: Install according to manufacturer written instructions.
 1. Install on concrete substrates that incorporate lightweight aggregates.
 2. Install concrete substrates that fail preinstallation moisture testing.
- F. Substrate-Crack-Suppression Membrane: Install to isolate and suppress substrate cracks according to manufacturer written instructions.
 1. Prepare and prefill substrate cracks with membrane material.
 2. Install membrane as recommended by terrazzo manufacturer in areas to receive terrazzo.
 3. Reinforce membrane with fiberglass scrim.
- G. Protect other work from water and dust generated by grinding operations. Control water and dust to comply with environmental protection regulations.
 1. Erect and maintain temporary enclosures and other suitable methods to limit water damage and dust migration and to ensure adequate ambient temperatures and ventilation conditions during installation.

3.3 EPOXY-RESIN TERRAZZO INSTALLATION

- A. Comply with NTMA written recommendations for terrazzo and accessory installation.
- B. Strip Materials:
 1. Divider and Control-Joint Strips:
 - a. Locate divider strips in locations indicated.
 - b. Install control-joint strips back to back and directly above concrete-slab control joints.
 - c. Install control-joint strips with 1/4-inch (6.4-mm) gap between strips, and install sealant in gap.

- d. Install strips in adhesive setting bed without voids below strips, or mechanically anchor strips as required to attach strips to substrate, as recommended by strip manufacturer.
- 2. Accessory Strips: Install as required to provide a complete installation.
- C. Apply primer to terrazzo substrates according to manufacturer written instructions.
- D. Place, rough grind, grout, cure grout, fine grind, and finish terrazzo according to manufacturer written instructions.
 - 1. Installed Thickness: 1/4 inch (6.4 mm) nominal.
 - 2. Terrazzo Finishing: Ensure that matrix components and fluids from grinding operations do not stain terrazzo by reacting with divider and control-joint strips.
 - a. Rough Grinding: Grind with 24-grit or finer stones or with comparable diamond abrasives. Follow initial grind with 60/80-grit stones or with comparable diamond abrasives.
 - b. Grouting: Before grouting, clean terrazzo with water, rinse, and allow to dry. Apply and cure epoxy grout.
 - c. Fine Grinding/Polishing: Delay fine grinding until heavy trade work is complete and construction traffic through area is restricted. Grind with 120-grit stones or with comparable diamond abrasives until grout is removed from surface.
 - 3. Installation Tolerance: Limit variation in terrazzo surface from level to 1/4 inch in 10 feet (6.4 mm in 3 m); noncumulative.
- E. Install and finish poured-in-place terrazzo stairs at the same time the adjacent terrazzo flooring is installed.
- F. Install and finish poured-in-place terrazzo base at the same time the adjacent terrazzo flooring is installed.

3.4 PRECAST TERRAZZO INSTALLATION

- A. Install precast terrazzo units using method recommended in writing by NTMA and manufacturer unless otherwise indicated.
- B. Do not install units that are chipped, cracked, discolored, or improperly finished.
- C. Seal joints between units with joint compound matching precast terrazzo matrix or joint sealant.

3.5 REPAIR

- A. Cut out and replace terrazzo areas that evidence lack of bond with substrate. Cut out terrazzo areas in panels defined by strips and replace to match adjacent terrazzo, or repair panels according to NTMA written recommendations, as approved by Architect.

3.6 CLEANING AND PROTECTION

A. Cleaning:

1. Remove grinding dust from installation and adjacent areas.
2. Wash surfaces with cleaner according to NTMA written recommendations and manufacturer written instructions; rinse surfaces with water and allow them to dry thoroughly.

B. Sealing:

1. Seal surfaces according to NTMA written recommendations.
2. Apply sealer according to sealer manufacturer written instructions.

C. Protection: Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure that terrazzo is without damage or deterioration at time of Substantial Completion.

END OF SECTION

NOT FOR BID

SECTION 09 68 13

TILE CARPETING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Modular carpet tiling.
2. Carpet tiling as area rug.

1.2 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.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include manufacturer written data on physical characteristics, durability, and fade resistance.
2. Include manufacturer written installation recommendations for each type of substrate.

B. Shop Drawings: For carpet tile installation, plans showing the following:

1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
2. Carpet tile type, color, and dye lot.
3. Type of subfloor.
4. Type of installation.
5. Pattern of installation.
6. Pattern type, location, and direction.
7. Pile direction.
8. Type, color, and location of 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 name, material description, color, pattern, and designation indicated on Drawings and in schedules.
 - 1. Carpet Tile: Full-size Sample.
 - 2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch- (300-mm-) long Samples.
- D. Samples for Initial Selection: For each type of carpet tile.
 - 1. Include Samples of exposed edge, transition, and other accessory stripping involving color or finish selection.
- E. Samples for Verification: For each of the following products and for each color and texture required. Label each Sample with manufacturer name, material description, color, pattern, and designation indicated on Drawings and in schedules.
 - 1. Carpet Tile: Full-size Sample.
 - 2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch- (300-mm-) long Samples.
- F. Product Schedule: For carpet tile. Use same designations indicated on Drawings.

1.4 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.

1.5 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 recommended maintenance schedule.
 - 2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.6 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. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 - 1. Build mockups at locations and in sizes as directed by Architect.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with the Carpet and Rug Institute CRI 104.

1.8 FIELD CONDITIONS

- A. Comply with the Carpet and Rug Institute CRI 104 for temperature, humidity, and ventilation limitations.
- B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.
- C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.
- D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

1.9 WARRANTY

- A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
 - 1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
 - 2. Failures include, but are not limited to, the following:
 - a. More than 10 percent edge raveling, snags, and runs.
 - b. Dimensional instability.
 - c. Excess static discharge.
 - d. Loss of tuft-bind strength.
 - e. Loss of face fiber.
 - f. Delamination.
 - 3. Warranty Period: Ten years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILE

- A. Manufacturers and Products: See Finish Legend on Drawings for Basis of Design products, sizes, and colors.
 - 1. Substitution Requests: Substitution Requests require a full sample of the tile to be dropped off at the Architect's office below. See Specification 012500 "Substitution Procedures" for additional information.

- a. Tevebaugh Architecture
Two Mill Road, Suite 210
Wilmington, DE 19806.
- B. Backing System: Manufacturer standard cushion backing at typical carpet tiling. Non-cushion backing at area rug conditions.
- C. Applied Treatments:
 - 1. Soil-Resistance Treatment: Manufacturer standard treatment.
 - 2. Antimicrobial Treatment: Manufacturer standard treatment that protects carpet tiles as follows:
 - a. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria, not less than 1-mm halo of inhibition for gram-negative bacteria, and no fungal growth, according to AATCC 174.

2.2 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and are recommended by carpet tile manufacturer for releasable installation.
- C. Metal Edge/Transition Strips: Extruded aluminum with mill finish of profile and width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

2.3 PERFORMANCE

- A. Accessibility Requirements: Applicable provisions in Department of Justice publication 2010 ADA Standards for Accessible Design and state accessibility code.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.
- B. Examine carpet tile for type, color, pattern, and potential defects.

- C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 03 30 00 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.
1. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. (18.6 sq. m), and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
 - b. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
 - c. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with the Carpet and Rug Institute CRI 104 and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile.
- B. Comply with manufacturer instructions and Section 09 05 61.
- C. Use trowelable leveling and patching compounds, according to manufacturer written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch (3 mm) wide or wider, and protrusions more than 1/32 inch (0.8 mm) unless more stringent requirements are required by manufacturer written instructions.
- D. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.
- E. Metal Substrates: Clean grease, oil, soil and rust, and prime if recommended in writing by adhesive manufacturer. Rough sand painted metal surfaces and remove loose paint. Sand aluminum surfaces, to remove metal oxides, immediately before applying adhesive.
- F. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION - GENERAL

- A. General: Comply with the Carpet and Rug Institute CRI 104, Section 10, "Carpet Tile," and with carpet tile manufacturer written installation instructions.
- B. Installation Method: Glue down; install every tile with full-spread, releasable, pressure-sensitive adhesive.
- C. Maintain dye-lot integrity. Do not mix dye lots in same area.

- D. Maintain pile-direction patterns recommended in writing by carpet tile manufacturer.
- E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
- F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.
- H. Install pattern parallel to walls and borders.

3.4 INSTALLATION - AREA RUG

- A. Exposed Edges: Hem all exposed edges and attach underside of carpet tiles with Velcro to substrate.
 - 1. Include cut edges at penetrations.
- B. Concealed Edges: Use manufacturer recommended tape and attach adjacent abutting tiles to each other.

3.5 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet tile:
 - 1. Remove excess adhesive and other surface blemishes using cleaner recommended by carpet tile manufacturer.
 - 2. Remove yarns that protrude from carpet tile surface.
 - 3. Vacuum carpet tile using commercial machine with face-beater element.
- B. Protect installed carpet tile to comply with the Carpet and Rug Institute CRI 104, Section 13 .7.
- C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION

NOT FOR BID

SECTION 09 72 00

WALL COVERINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Results:
 - 1. Adhesive applied wall coverings.
- B. Principal Products:
 - 1. Textile wall coverings.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordination Procedures:
 - 1. Coordinate surface preparations with substrate installation and painting.
- B. Preinstallation Meeting Attendees and Procedures:
 - 1. Conduct meeting one week, minimum, before starting Work of this Section.

1.3 ACTION SUBMITTALS

- A. Product Data: Each type of wall covering.
- B. Shop Drawings: Wall elevations with seaming layout.
 - 1. Include location schedule by room number and wall covering type.
- C. Samples:
 - 1. Wall Coverings: 24 inches by full width.
 - 2. Wall Coverings: 6 by 6 inches in size.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Cleaning recommendations.

1.5 MAINTENANCE MATERIALS

A. Extra Stock Materials:

1. Wall Covering: 9 linear yards of each product.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Installers: Member of the Wallcovering Installers Association.

B. Field Samples: Apply wall covering; full height, 2 rolls wide. Demonstrate pattern.

1. Approved Samples establish Work results standard.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store materials indoors.

B. Protect packaged adhesive from temperature cycling and cold temperatures.

C. Do not store roll goods on end.

1.8 FIELD CONDITIONS

A. Ambient Conditions: Perform Work within following limitations.

1. Building enclosed and environmental systems maintaining design conditions for Owner occupancy.
2. Lighting: Permanent lighting or temporary illumination providing 80 footcandles at mid-height of wall, minimum.

PART 2 - PRODUCTS

2.1 WALL COVERINGS

A. Wall Covering: Textile.

1. Manufacturers and Products: See Finish Legend on Drawings.

2.2 PERFORMANCE

A. Surface Burning: ASTM E84 Class A.

1. Flame Spread Index: 25, maximum.
2. Smoke Developed Index: 450, maximum.

2.3 INSTALLATION MATERIALS

- A. Adhesive: Manufacturer recommended type to suit application, mildew resistant.
 - 1. VOC Content: 50 g/L, maximum.
- B. Termination Trim: Extruded aluminum.
 - 1. Color: Architect selected.
- C. Substrate Filler: Adhesive and wall covering manufacturer recommended; compatible with substrate.
- D. Substrate Primer and Sealer: Acrylic latex enamel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify substrate surfaces are ready to receive Work.
- B. Verify flatness tolerance of surfaces does not vary more than 1/8 inch in 10 feet nor vary at rate greater than 1/16 inch per foot.

3.2 PREPARATION

- A. Fill cracks in substrate and smooth irregularities with filler; sand smooth.
- B. Wash impervious surfaces with tetrasodium or trisodium phosphate, rinse and neutralize; wipe dry.
- C. Surface Appurtenances: Remove electrical plates, hardware, light fixture trim, escutcheons, and fittings before preparing surfaces or finishing.
- D. Surfaces: Correct defects and clean surfaces. Remove existing coatings that exhibit loose surface defects.
- E. Marks: Seal with shellac those which may bleed through surface finishes.
- F. Apply one coat of primer sealer to substrate surfaces. Allow to dry. Lightly sand smooth.
- G. Vacuum surfaces.

3.3 INSTALLATION

- A. Install wall covering in roll number sequence.
- B. Razor trim edges on flat work table, changing blade often to prevent rough cut edges. Do not razor cut on gypsum board surfaces.

- C. Apply covering smooth, without wrinkles, gaps or overlaps. Eliminate air pockets and ensure full bond to substrate surface. Butt edges tight.
- D. Match pattern 72 inches above finished floor.
- E. Horizontal seams are not acceptable.
- F. Do not seam within 2 inches of internal corners nor within 6 inches of external corners.
- G. Install wall covering before installation of bases, cabinets, and wall mounted items Install 1/4 inch, minimum, below top of resilient base.
- H. Apply wall covering behind radiation and convector covers.
- I. Where wall covering tucks into reveals, or metal wallboard or plaster stops, apply wall covering with contact adhesive within 6 inches of wall covering termination. Ensure full contact bond.
- J. Install termination trim.
- K. Remove excess adhesive. Wipe clean with dry cloth.

3.4 CLEANING

- A. Clean wall coverings of excess adhesive, dust, dirt, and other contaminants.
- B. Reinstall wall plates and accessories removed before Work of this section.

END OF SECTION

SECTION 09 83 00
ACOUSTIC FINISHES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Acoustical plaster system.
 2. Drapery and track system.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of products.
1. Initial selection color Samples.
 2. Track System: Include maximum weight capacity.
- B. Shop Drawings:
1. Track System: Installation and anchorage details. Show location of controls.
 2. Drapes: Size, locations, and details of installation.
- C. Samples:
1. Plaster: 3 inch square Sample of StarSilent System showing texture and color.
 2. Drape Fabrication: For each heading, fabric, color, and pattern. Full sized Samples panel. Approve Samples may be incorporated into Work.
 3. Track System: 18 inches long section with carriers, controls, and accessories.
 4. Textile Trim: 18 inches long section.
 5. Drape Fabric: For each color and pattern, 36 inches long, mark top and face of fabric.
- D. Schedules: For each fabric types. Use same designations indicated on Drawings.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For each flame retardant treated fabric, signed by fabric supplier, indicating treatment durability, and cleaning procedures to maintain treatment effectiveness.
- C. Manufacturer Test Reports: For acoustical data.
- D. Product Test Reports: For each type of drapery material, for tests performed by a qualified testing agency.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Materials:

1. Track Carriers: 5 percent of amount installed, but not less than five of each size.
2. Track Controls: 5 percent of amount installed, but not less than five of each type.
3. Drape Fabric: Full width lengths equal to 5 percent of amount installed, but not less than 10 yards of each fabric, color, and pattern.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications:

1. Applicator of plaster system.
2. Fabricator of drapery.

- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

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

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store materials according to manufacturer instructions.
- B. Protect plaster materials from moisture, freezing, and dust by storing in clean, dry location remote from construction operations areas.

1.8 FIELD CONDITIONS

- A. Ambient Conditions: Perform work within following limitations:

1. Building enclosed and environmental systems maintaining design conditions for Owner occupancy.
2. Finish work in spaces, including painting, is complete and dry.

- B. Existing Conditions: Verify field measurements before fabrication. Show field measurements on Shop Drawings.

- C. Field Measurements: Where drapery and track system are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed

units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.9 WARRANTY

- A. Plaster System: Manufacturer standard material warranty.
 - 1. Warranty Period: Five years from date from Substantial Completion.

PART 2 - PRODUCTS

2.1 ACOUSTICAL PLASTER SYSTEM

- A. Sound-absorbing plaster finish system: Two coat plaster finish on recycled crushed glass board fastened to rigid ceiling framing.
 - 1. Manufacturer and Product: Pyrok, Inc., The StarSilent System, as basis of design.
 - a. Finish: Smooth.
 - b. Color: White.
- B. Performance:
 - 1. Surface Burning Characteristics: ASTM E84, 15.
 - 2. Sound Transmission Class: ASTM E90, 30 STC.

2.2 HAND DRAW TRACK SYSTEM

- A. Hand Draw Track System: Manually operated, channel track system, and as follows:
 - 1. Manufacturers and Products: See Finish Legend on Drawings.
 - 2. Stacking: See Drawings.
 - 3. Support Cable: Manufacturer standard galvanized stranded steel wire rope.
 - 4. Channel Track: Galvanized steel, slotted mounting 24 inches on center.
 - a. Configuration: See Drawings.
 - b. Finish: White baked enamel.
 - c. Mounting: Ceiling, surface.
 - 5. Mounting Brackets: Galvanized steel.
 - 6. Operation: Hand draw.
 - a. Draw: Two way, center opening.
 - 7. Carriers: Coordinate with drapery headings.
 - 8. End Stops: Manufacturer standard.

B. Performance:

1. Accessibility Requirements: Applicable provisions in Department of Justice publication 2010 ADA Standards for Accessible Design and state accessibility code.

2.3 DRAPES

A. Double Sided Drapes:

1. Stack Pleats:
 - a. Percent Fullness: 40.
 - b. Pleat Spacing: 6 inches.
2. Heading:
 - a. Flat Panel.
 - 1) Grommet Finish: Stainless Steel.
 - b. Accessories: Reinforce hem with integrated snap connections.
3. Hem Weights: 1 inch square lead weights.
4. Fabric: See Finish Legend.
5. Interlining: Acoustical.
6. Orientation: Run right up to bolt.

B. Performance:

1. Fire Resistance: NFPA 701.

2.4 DRAPE FABRICATION

- A. If less than a full fabric width is required to produce specified panel fullness, use equal widths of not less than one half fabric width, located at each panel ends.
 1. Two Way Stacking Drapes: Add 10 inches to overall width for returns.
- B. Seams: Sew vertical seams with twin needle sewing machine with selvage trimmed and overlocked.
 1. Join widths to match pattern.
 2. Vertical Seams: Lay flat without puckering.
 3. Horizontal Seams: Unacceptable.
- C. Side Hems: Double turned, 1-1/2 inches wide hems, three layers of fabric, and blindstitched.
- D. Bottom Hems: Double turned, 4 inches wide hems, three layers of fabric, weighed, and blindstitched.
 1. Hem Weights: Sew in at each seam and panel corners.

- E. Linings: Equal to drape fabric widths.
 - 1. Join top by inside invisible seam.
 - 2. Join sides by hand stitched and shadowed with 1-1/2 inches face fabric return.
 - 3. Bottom Hem: Hem separately from drape fabric.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with plaster manufacturer requirements.
- B. Verify concealed support locations for drapery track attachment.

3.2 PREPARATION

- A. Clean substrates of substances, including dirt, oil, grease, and incompatible materials, that could impair bond of coatings. Do not apply plaster finish coats when temperatures are below 55° F.

3.3 INSTALLATION - PLASTER SYSTEM

- A. Application: Comply with manufacturer written instructions.
 - 1. Install 1-1/2 inches cold rolled channel on 4 feet centers and 20 gage 7/8 inch hot channel on 15-3/4 inches centers.
 - 2. Fasten StarSilent panels to framing.
 - 3. Apply StarSilent fix to panel edges and over fasteners.
 - 4. Sand over fasteners and panel seams.
 - 5. Apply StarSilent Top Basic over entire surface.
 - 6. Apply StarSilent Top Finish over entire surface and trowel to smooth plaster finish.
 - 7. Allow plaster installation to cure by natural or mechanical ventilation.

3.4 INSTALLATION - DRAPERY AND TRACK

- A. Install track level and plumb, aligned with adjacent units, and centered on openings.
- B. Isolate metal track parts from concrete, masonry, and mortar to prevent galvanic action.
- C. Drapes abutting overhead construction: Maintain 1/4 inch clearance between heading and overhead construction.
- D. Drapes extending to windowsill: Maintain bottom hem above sill line, not more than 1/2 inch.

3.5 ADJUSTING

- A. Test and adjust hanged drapes for unencumbered track operation.

- B. Steam drapes to produce crease and wrinkle free installation.
- C. Remove and replace stained or soiled drapes.

3.6 CLEANING

- A. Remove fallout material immediately upon completion of the work in each area.
- B. Clean plaster surfaces to remove evidence of soiling.
- C. Clean track metal and drapery fabric surfaces.
- D. Repair or replace damaged work surfaces to acceptable conditions.

END OF SECTION

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SECTION 09 90 00
PAINTING AND COATING

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Results:
 - 1. Painting interior and exterior substrates.
- B. Principal Products:
 - 1. Primers and paints.

1.2 ACTION SUBMITTALS

- A. Product Data:
 - 1. Initial selection color charts.
- B. Samples:
 - 1. Draw Down Samples: Each type of paint system and each topcoat color and gloss.
 - a. Label each Sample for paint type, location, and substrate.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data:
 - 1. Cleaning, touch-up, and repair instructions for painted and coated surfaces.
 - 2. Area summary with finish schedule and color samples, designating where each product, color and finish was used.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Materials:
 - 1. Paint from same product run as installed materials.
 - a. Quantity: 5 percent, but not less than 1 gallon of each material and color.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements:

1. Store paint products in sealed containers until ready for use.

1.6 FIELD CONDITIONS

- A. Apply materials only when surface and ambient temperatures are within temperature ranges required by paint product manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers and Products: See Finish Legend on Drawings for Basis of Design products, sizes, and colors.

1. Substitution Requests: Substitution Requests require a full sample of the applied products to be dropped off at the Architect's office below. See Specification 012500 "Substitution Procedures" for additional information.

- a. Tevebaugh Architecture
Two Mill Road, Suite 210
Wilmington, DE 19806.

- B. Products: Scheduled in this Section.

2.2 PAINT, GENERAL

- A. Paint Systems: Primers, intermediate coats and topcoats compatible with substrates and one another.

- B. Coatings: Ready mixed or field-catalyzed.

- C. Preparation:

1. Mix to soft paste consistency, capable of being readily and uniformly dispersed to homogenous coating.
2. Blend tints and catalyzers to uniform consistency and color, capable of drying or curing free of streaks or sags.

2.3 SOURCE QUALITY CONTROL

- A. Tests:

1. Testing: Owner may engage a qualified testing agency to sample paint materials delivered to project site or taken from supplier's facility.
2. Acceptance Criteria: Products comply with specified requirements.

- B. Non-Conforming Work: Remove materials from substrates, pay for testing of replacement products, and repaint surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Verify substrates are ready to receive work.
- B. Preinstallation Testing: Test moisture content of substrate does not exceed the following:
 - 1. Concrete: 12 percent.
 - 2. Masonry: 12 percent.
 - 3. Wood: 15 percent.
 - 4. Gypsum Board and Plaster: 12 percent.
- C. Gypsum Board: Verify that finishing compound is dried and sanded smooth.
- D. Plaster: Verify that plaster is cured.
- E. Concrete: Verify surface has cured at least 30 days and that the pH of the surface is between 6 and 9.

3.2 PREPARATION

- A. Surface Preparation: Remove electrical plates, hardware, trim, escutcheons, and fittings. Correct defects in substrates capable of affecting work.
- B. Cleaning: Remove substances that could impair paint bond, including dust, oil, grease, and incompatible coatings.
 - 1. Aluminum Surfaces: Remove surface contamination by steam or high pressure water. Remove oxidation with acid etch and solvent washing. Apply etching primer immediately following cleaning.
 - 2. Asphalt, Creosote, or Bituminous Surfaces: Remove foreign particles to permit adhesion of finishing materials. Apply compatible sealer or primer.
 - 3. Gypsum Board Surfaces: Fill minor defects with filler compound. Spot prime defects after repair.
 - 4. Plaster Surfaces: Fill cracks, holes, and other imperfections with latex patching plaster. Blend texture with adjacent surfaces. Clean and allow to dry.
 - 5. Concrete and CMU Surfaces: Remove dirt, loose mortar, scale, efflorescence and chalk. Remove oil and grease by scrubbing with cleaning solution recommended by finish coating manufacturer. Rinse with clean water and allow surface to dry.
 - 6. Non-Passivated Galvanized Surfaces: Smooth and hand or power tool clean per ASTM D6386.
 - 7. Passivated Galvanized Surfaces: Remove soluble and insoluble contaminants and corrosion. Sweep blast per ASTM D6386 to achieve uniform 1.0 to 2.0 mil anchor profile.
 - 8. Uncoated Steel: Remove rust and loose mill scale. Clean per SSPC- SP 3 "Power Tool Cleaning."
 - 9. Primed Steel: Clean field welds, fasteners, and abraded shop primer.
 - 10. Wood Surfaces:

- a. Wipe off dust and grit. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried.
- b. Backprime concealed surfaces.

3.3 APPLICATION

- A. Follow manufacturer instructions for application method, thickness of coatings, and number of coats.
 1. Apply finishes when surfaces are dry. Allow applied coats to dry before next coat is applied.
 2. Apply each coat of paint slightly darker than preceding coat.
 3. Apply coatings to uniform appearance.
 4. Sand wood and metal surfaces lightly between coats.
 5. Leave testing agency, equipment identification, and performance labels unpainted.
- B. Appearance:
 1. Apply paints without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, or other imperfections.
 2. Edges and Color Breaks: Produce sharp edges.

3.4 PAINTING MECHANICAL EQUIPMENT

- A. Paint the following equipment when exposed in equipment rooms and occupied spaces:
 1. Electrical panelboards and switchgear.
 2. Piping.
 3. Ductwork.
 4. Pipe hangers.
 5. Conduit.
 6. Shop-primed equipment.
- B. Paint interior surfaces of air ducts visible through grilles with one coat of flat black paint.

3.5 FIELD QUALITY CONTROL

- A. Field Tests and Inspections: Engage inspectors to perform tests and inspections and prepare reports. Allow inspectors access to work areas.
 1. Failed Test Retest Cost: Contractor responsibility.
- B. Testing: Dry film thickness.
- C. Non-Conforming Work: Remove and replace or apply additional coats, and re-test.

3.6 CLEANING

A. Cleaning:

1. Remove rubbish, empty cans, rags, and other discarded materials.
2. Remove splattered paints. Protect adjacent surfaces from damage.

3.7 PROTECTION

- #### A. Protection: Protect painted surfaces from subsequent construction work. Touch up and restore damaged painted surfaces.

3.8 INTERIOR PAINTING SCHEDULE

A. Concrete Walls and Ceilings - Dry Environments:

1. Latex primer:
 - a. BEHR: Premium Plus Multi-Surface Primer & Sealer 436.
 - b. Benjamin Moore: Ultra Spec Masonry 100% Acrylic Sealer 608.
 - c. PPG Paints: Perma-Crete Interior/Exterior Alkali Resistant Primer 4-603XI.
 - d. Sherwin-Williams: Loxon Concrete & Masonry Primer, LX02 Series.
2. Acrylic-Latex Enamel: Semi-gloss finish.
 - a. BEHR: Behr Pro i300 Interior.
 - b. Benjamin Moore: Ultra Spec 500 Series.
 - c. PPG Paints: SPEEDHIDE Zero Interior Latex.
 - d. Sherwin-Williams: ProMar 200 Zero VOC Interior Latex.
3. Water-Based Epoxy Topcoat: Semi-gloss finish.
 - a. BEHR: Behr Pro Pre-Catalyzed Waterborne Epoxy.
 - b. Benjamin Moore: COROTECH WB Pre-Cat Epoxy Coating.
 - c. PPG Paints: Pitt-Glaze WB1 Interior Pre-Catalyzed Acrylic Epoxy.
 - d. Sherwin-Williams Pro Industrial Water Based Catalyzed Epoxy, B73-300 Series.

B. Concrete Walls and Ceilings -Wet Environments:

1. Primer:
 - a. BEHR: Premium Plus Multi-Surface Primer & Sealer 436.
 - b. Benjamin Moore: Ultra Spec 500 Series.
 - c. PPG Paints: Amerlock 400BF.
 - d. Sherwin-Williams: Loxon Concrete and Masonry Primer/Sealer.
2. Epoxy Topcoat: Semi-gloss finish.
 - a. BEHR: US Coatings EpoxyGrip 2000 VOC Epoxy Mastic Coating.
 - b. Benjamin Moore: Corotech Surface Tolerant Epoxy Mastic Coating V160.
 - c. PPG Paints: Aquapon WB EP Epoxy.
 - d. Sherwin-Williams: Pro Industrial Water Based Catalyzed Epoxy B73 Series.

C. CMU Substrates - Dry Environments:

1. Latex Block Filler:
 - a. BEHR: Behr Pro Block Filler Primer, PR50.
 - b. Benjamin Moore: Ultra Spec® Masonry Hi-Build Block Filler 571.
 - c. PPG Paints: 6-7 Speedhide Latex Block Filler.
 - d. Sherwin-Williams: PrepRite Latex Block Filler, B25W25.
2. Acrylic-Latex Enamel: Semi-gloss finish.
 - a. BEHR: Behr Pro i300 Interior.
 - b. Benjamin Moore: Ultra Spec® 500 Series.
 - c. PPG Paints: SPEEDHIDE Zero Interior Latex.
 - d. Sherwin-Williams: ProMar 200 Zero VOC Interior Latex.

D. Gypsum Board and Plaster Walls:

1. Latex Primer:
 - a. BEHR: Drywall Plus Primer & Sealer No. 73.
 - b. Benjamin Moore: Ultra Spec 500 Interior Latex Primer N534.
 - c. PPG Paints: SPEEDHIDE zero Interior Latex Sealer 6-4900XI.
 - d. Sherwin-Williams: ProMar 200 Zero VOC Interior Latex Primer B28W02600.
2. Acrylic-Latex Enamel: Eggshell and Semi-gloss finish.
 - a. BEHR: Behr Pro i300 Interior.
 - b. Benjamin Moore: Ultra Spec® 500 Series.
 - c. PPG Paints: SPEEDHIDE Zero Interior Latex.
 - d. Sherwin-Williams: ProMar 200 Zero VOC Interior Latex.

E. Gypsum Board and Plaster Ceilings:

1. Latex Primer:
 - a. BEHR: Drywall Plus Primer & Sealer No. 73.
 - b. Benjamin Moore: Ultra Spec 500 Interior Latex Primer N534.
 - c. PPG Paints: SPEEDHIDE zero Interior Latex Sealer 6-4900XI.
 - d. Sherwin-Williams: ProMar 200 Zero VOC Interior Latex Primer B28W02600.
2. Acrylic-Latex Enamel: Eggshell and Semi-gloss finish.
 - a. BEHR: Behr Pro i100 Interior.
 - b. Benjamin Moore: Ultra Spec® 500 Series.
 - c. PPG Paints: SPEEDHIDE Zero Interior Latex.
 - d. Sherwin-Williams: ProMar 200 Zero VOC Interior Latex.

F. Steel Doors and Frames:

1. Pre-Primed Metal: Touch up with same shop primer product used by manufacturer.
2. Latex Primer:
 - a. BEHR: Premium Plus Multi-Surface Primer & Sealer 436.

- b. Benjamin Moore: Ultra Spec HP Acrylic Metal Primer HP04.
 - c. PPG Paints: Pitt-Tech Plus DTM 4020PF.
 - d. Sherwin-Williams: Pro Industrial Pro-Cryl Universal Primer B66-1310 Series.
 - 3. Waterbased Alkyd Enamel: Semi-gloss finish.
 - a. BEHR: Urethane Alkyd Enamel.
 - b. Benjamin Moore: ADVANCE Waterborne Interior Alkyd.
 - c. PPG Paints: SPEEDHIDE Interior/Exterior WB Alkyd.
 - d. Sherwin-Williams: Pro Industrial Waterbased Alkyd Urethane.
- G. Steel Railings:
- 1. Pre-Primed Metal: Touch up with same shop primer product used by manufacturer.
 - 2. Latex Primer:
 - a. BEHR: Premium Plus All-in-One Primer & Sealer 75.
 - b. Benjamin Moore: Ultra Spec HP Acrylic Metal Primer HP04.
 - c. PPG Paints: Pitt-Tech Plus DTM 4020PF.
 - d. Sherwin-Williams: Pro Industrial Pro-Cryl Universal Primer B66-1310 Series.
 - 3. Waterbased Alkyd Enamel: Semi-gloss finish.
 - a. BEHR: Urethane Alkyd Enamel.
 - b. Benjamin Moore: ADVANCE Waterborne Interior Alkyd.
 - c. PPG Paints: SPEEDHIDE Interior/Exterior WB Alkyd.
 - d. Sherwin-Williams: Pro Industrial Waterbased Alkyd Urethane.
 - 4. Epoxy Topcoat: Semi-gloss finish.
 - a. BEHR: Behr Pro Pre-Catalyzed Waterborne Epoxy.
 - b. Benjamin Moore: Corotech Pre Catalyzed Epoxy.
 - c. PPG Paints; PITT-GLAZE WB1 Interior Pre-Catalyzed Water-Borne Acrylic Epoxy.
 - d. Sherwin-Williams: Pro Industrial Pre-Catalyzed Water Based Epoxy.
- H. Galvanized Steel Substrates:
- 1. Latex Primer:
 - a. BEHR: Premium Plus Multi-Surface Primer & Sealer 436.
 - b. Benjamin Moore: Ultra Spec HP Acrylic Metal Primer HP04.
 - c. PPG Paints: Pitt-Tech Plus DTM 4020PF.
 - d. Sherwin-Williams: Pro Industrial Pro-Cryl Universal Primer B66-1310 Series.
 - 2. Acrylic-Latex Enamel: Semi-gloss finish.
 - a. BEHR: PREMIUM Interior/Exterior Direct to Metal Paint.
 - b. Benjamin Moore: Ultra Spec HP D.T.M Acrylic Enamel.
 - c. PPG Paints: Pitt-Tech Plus Interior/Exterior DTM Industrial Enamel 4216 SG or 90 Series.
 - d. Sherwin-Williams: Pro Industrial Acrylic.

I. Wood Trim and Base:

1. Latex Primer:

- a. BEHR: Premium Plus All-in-One Primer & Sealer 73.
- b. Benjamin Moore: Advance Waterborne Interior Alkyd Primer 790.
- c. PPG Paints: Seal-Grip Interior/Exterior Universal Primer/Sealer 17-921XI.
- d. Sherwin-Williams: PrepRite ProBlock Interior/Exterior Latex Primer/Sealer B51-600.

2. Acrylic-Latex Enamel: Flat, Semi-gloss, or Gloss finish.

- a. BEHR: Behr Pro i100 Interior.
- b. Benjamin Moore: Ultra Spec® 500 Series.
- c. PPG Paints: SPEEDHIDE Zero Interior Latex.
- d. Sherwin-Williams: ProMar 400 Zero VOC Interior Latex.

3.9 SPECIALTY INTERIOR PAINTING SCHEDULE

A. Scuff-Resistant Coatings:

1. Latex Primer:

- a. BEHR: Multi-Surface Interior/Exterior Primer & Sealer 436.
- b. Benjamin Moore: Ultra Spec 500 Interior Latex Primer N534.
- c. PPG Paints: Seal Grip 17-921XI.
- d. Master Coating Technologies: Scuffmaster Primer/Sealer.
- e. Sherwin-Williams: ProMar 200 Zero VOC Interior Latex Primer B28W02600.

2. Scuff-Resistant Latex: Eggshell or Semi-gloss finish.

- a. BEHR: ULTRA SCUFF DEFENSE.
- b. Benjamin Moore: Ultra Spec Scuff-X.
- c. PPG Paints: UltraLast Interior.
- d. Master Coating Technologies: Scuffmaster Scrubtough.
- e. Sherwin-Williams: Scuff Tough Latex.

B. Metallic Coatings:

1. Primer:

- a. Master Coating Technologies: Scuffmaster Primer/Sealer.

2. Coating System: Base color, effect coat and clear topcoat.

- a. Master Coating Technologies: Solid Metal.

C. High-Traffic Coatings:

1. Description:

- a. Basis of Design: Master Coating Technologies: Scuffmaster Armor.
- b. Primer: As recommended by paint manufacturer suitable for substrate.

- c. Coating System: Water-based polyurethane/acrylic base coat and cross-linker.
- 2. Performance:
 - a. VOC: Coatings shall have 80 g/l of VOC's.
 - b. Fire Rating: Coatings shall be Type I or Class A fire-rated, ASTM E 84.
 - c. Scrub Test: Greater than 25,000 cycles, ASTM D 2486.
 - d. Impact Resistance: Greater than 60 in/lbs, ASTM D 2794.
 - e. Chemical Resistance: 10, test maximum, for all chemicals tested, ASTM D 1308.
 - f. Stain Removal: 8 to 10, test maximum, for all stains tested, four-hour Open Spot Test.

3.10 EXTERIOR PAINTING SCHEDULE

A. Concrete Nontraffic Surfaces:

- 1. Primer:
 - a. BEHR: Multi-Surface Interior/Exterior Primer & Sealer 436.
 - b. Benjamin Moore: Ultra Spec Int/Ext Masonry sealer (608).
 - c. PPG Paints: PERMA-CRETE Interior/Exterior Alkali Resistant Primer.
 - d. Sherwin-Williams: Loxon Concrete and Masonry Primer/Sealer LX02.
- 2. Exterior Acrylic-Latex Topcoat: Eggshell or Semi-gloss finish.
 - a. BEHR: PRO e600 Exterior Paint.
 - b. Benjamin Moore: Ultra Spec Exterior Enamel.
 - c. PPG Paints: SPEEDHIDE Exterior Latex.
 - d. Sherwin-Williams: Pro Industrial Acrylic B66-600 Series.

B. CMU Substrates:

- 1. Latex Block Filler:
 - a. BEHR: Behr Pro Block Filler Primer, PR50.
 - b. Benjamin Moore: Ultra Spec Masonry Hi-Build Block Filler 571.
 - c. PPG Paints; Perma-Crete Concrete Block & Masonry Surfacer/Filler.
 - d. Sherwin-Williams: Conflex XL Block Filler, CF01W50.
- 2. Exterior Latex Topcoat: Eggshell or Semi-gloss finish.
 - a. BEHR: PRO e600 Exterior Paint.
 - b. Benjamin Moore: Ultra Spec Exterior Enamel.
 - c. PPG Paints: SPEEDHIDE Exterior Latex.
 - d. Sherwin-Williams: A100 Series Exterior Latex.

C. Unprimed Ferrous Metal:

- 1. Rust-Inhibitive Alkyd Primer:
 - a. BEHR: Interior/Exterior Metal Primer 435.
 - b. Benjamin Moore: Super Spec HP Alkyd Metal Primer P06.
 - c. PPG Paints: Devguard 4360.

- d. Sherwin-Williams: Kem Bond HS, B50 Series.
 - 2. Latex Topcoat: Semi-gloss finish.
 - a. BEHR: PREMIUM Direct to Metal Semi-Gloss Paint 3200.
 - b. Benjamin Moore: Ultra Spec HP D.T.M. Acrylic HP29.
 - c. PPG Paints: Pitt-Tech Plus Interior/Exterior DTM Industrial Enamel 4216 Series.
 - d. Sherwin-Williams: Pro Industrial Acrylic B66-600 Series.
- D. Galvanized Steel:
- 1. Primer:
 - a. BEHR: Multi-Surface Interior/Exterior Primer & Sealer 436.
 - b. Benjamin Moore: Ultra Spec HP D.T.M. Acrylic HP29.
 - c. PPG Paints: Pitt-Tech Plus DTM Primer 4020PF.
 - d. Sherwin-Williams: Pro Industrial ProCryl Universal Primer B66-1300 Series.
 - 2. Latex Topcoat: Semi-gloss finish.
 - a. BEHR: PREMIUM Direct to Metal Semi-Gloss Paint 3200.
 - b. Benjamin Moore: Ultra Spec HP D.T.M. Acrylic HP29.
 - c. PPG Paints: Pitt-Tech Plus Interior/Exterior DTM Industrial Enamel 4216 Series.
 - d. Sherwin-Williams: Pro Industrial Acrylic B66-600 Series.
- E. Aluminum:
- 1. Primer:
 - a. BEHR: PREMIUM PLUS Exterior Multi-Surface Primer & Sealer 436.
 - b. Benjamin Moore: Corotech Waterborne Bonding Primer (V175).
 - c. PPG Paints: Pitt-Tech Plus 4020PF.
 - d. Sherwin-Williams: Pro Industrial ProCryl Universal Primer B66-1310 Series.
 - 2. Latex Topcoat: Semi-gloss finish.
 - a. BEHR: Interior/Exterior Direct To Metal Semi-Gloss Paint 3200.
 - b. Benjamin Moore: Ultra Spec HP D.T.M. Acrylic HP29.
 - c. PPG Paints: Pitt-Tech Plus Interior/Exterior DTM Industrial Enamel 4216 Series.
 - d. Sherwin-Williams: Pro Industrial Acrylic B66-600 Series.
- F. Stainless Steel:
- 1. Primer:
 - a. BEHR: Kilz Adhesion Water-Base Bonding Primer, 2111.
 - b. Benjamin Moore: Corotech Waterborne Bonding Primer V175.
 - c. PPG Paints Pitt-Tech Plus 4020PF.
 - d. Sherwin-Williams DTM Wash Primer, B71Y1.
 - 2. Latex Topcoat: Semi-gloss finish.
 - a. BEHR: Interior/Exterior Direct To Metal Semi-Gloss Paint 3200.
 - b. Benjamin Moore: Ultra Spec HP D.T.M. Acrylic HP29.

- c. PPG Paints: Pitt-Tech Plus Interior/Exterior DTM Industrial Enamel 4216 Series.
- d. Sherwin-Williams: Pro Industrial Acrylic B66-600 Series.

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SECTION 09 96 10

EXTERIOR HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes surface preparation and application of high-performance coating systems on the following substrates:
 - 1. Exterior Substrates: Coating of every exterior substrate not otherwise indicated to be finished including but not limited to:
 - a. Steel.
 - b. Galvanized metal.
 - c. Exterior surfaces not otherwise prefinished or indicated for other finish.
- B. Related Work Specified Elsewhere.
 - 1. Section 090190 "Maintenance Exterior Repainting"
 - 2. Section 099726 "Mineral Coating"

1.2 DEFINITIONS

- A. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
- B. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include preparation requirements and application instructions. Include VOC content.
- B. Exterior High Performance System Schedule: For each substrate and top coat submit a schedule indicating each product recommended by manufacturer in compliance with requirements indicated herein. Submit on coating manufacturer's title block, signed by an authorized technical representative of the manufacturer.
- C. Samples for Initial Selection: For each type of topcoat product indicated.
- D. Samples for Verification: For each type of coating system and in each color and gloss of topcoat indicated.
 - 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. Label each Sample for location and application area.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Coatings: 2 percent, but not less than 2 gal. of each material and color applied.

1.5 QUALITY ASSURANCE

- A. Applicator Qualifications: Company who has completed 5 high performance coating projects of similar scope and complexity in the last 3 years and who is familiar with the products and substrates required for this Project.
- B. Source Limitations: Obtain all coatings for project from single manufacturer.
- C. Manufacturer's Technical Representative Services: An authorized and approved technical representative of the coating manufacturer shall visit the project site, evaluate the existing substrates and coatings and make recommendations for the best coating within their product line for the conditions present.

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 coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 50 and 95 deg F.
- B. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
- C. Do not apply exterior coatings in snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: For each product match the coating type, composition and performance of the basis of design product. Provide two-part coatings when basis of design product is two part.
1. Tnemec Company, (Basis of Design)
 2. Carboline
 3. PPG Architectural Finishes, Inc.
 4. Sherwin-Williams Company (The).

2.2 HIGH-PERFORMANCE COATINGS, GENERAL

- A. Provide products that comply with MPI standards indicated and are recommended by manufacturer to suit substrate, application and finish coat.
- B. Material Compatibility:
1. Provide materials for use within each coating 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 coating system, provide products recommended in writing by manufacturers of topcoat for use in coating system and on substrate indicated.
 3. Provide products of same manufacturer for each coat in a coating system.
- C. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior coatings applied at project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
1. OTC Model Rule II – Industrial and Exterior Coatings -250 g/l
- D. Colors: As selected by Architect from manufacturer's full range. 4 colors will be required.

2.3 PRIMERS

- A. Block Filler, Epoxy: Tnemec Series 1254 Epoxoblock WB
- B. Primer, Zinc-Rich, Moisture-Cured Urethane: Tnemec 90-97 Tneme-Zinc
- C. Epoxy, High-Build, Low Gloss: Tnemec Series V69/V69F Hi-Build Epoxoline II

- D. Prime Coat: Primer, Epoxy, Anti-Corrosive, for Metal: Tnemec Series V69/V69F Hi-Build Epoxoline II

2.4 HIGH PERFORMANCE INTERMEDIATE COAT

- A. Interior CMU, Inorganic Waterborne Epoxy, Underneath Waterborne Polyurethane
 - 1. Tnemec Series 27WB Typoxy
- B. Epoxy Underneath Metallic Topcoat
 - 1. Tnemec Series V69/V69F Hi-Build Epoxoline II

2.5 HIGH PERFORMANCE TOP COATINGS

- A. Polyurethane, Two-Component, Pigmented, Gloss (Gloss Level 6):
 - 1. Tnemec Endura Shield Series1080 or equivalent by approved manufacturers.

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.
 - 1. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - a. Concrete: 12 percent.
 - b. Masonry (Clay and CMU): 12 percent.
 - c. Wood: 15 percent.
 - d. Gypsum Board: 12 percent.
- B. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- C. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 SURFACES NOT TO BE FIELD COATED

- A. Areas scheduled for paint in Painting: Division 9.
- B. Areas of the existing building scheduled for coating in Section 090190 "Maintenance Exterior Repainting"
- C. Stucco at the existing building scheduled for coating in Section 099726 "Mineral Coating"
- D. Areas scheduled "unpainted or uncoated", except for specific elements in uncoated areas which area indicated to be coated.
- E. Exposed concrete on exterior of building, unless otherwise indicated.
- F. Calcium silicate masonry units, cast stone, natural stone or other similar masonry, unless otherwise indicated.
- G. Stainless steel, pre-finished aluminum, or other pre-finished metal, unless otherwise indicated.
- H. Exterior sealant types.
- I. Finish hardware, except hardware that is factory primed.
- J. Rating labels on doors and frames. Mask off.
- K. Work furnished with complete factory finish, except items indicated to receive finish coat under this Section.
- L. Other surfaces with integral finish such as glass, roofing and waterproofing, unless otherwise indicated.
- M. Exterior surfaces of exposed to view air ducts, plenums and other similar surfaces.]

3.3 SURFACES TO BE FIELD COATED

- A. Except for "Surfaces Not to be Field Coated" listed above, field coat every exterior surface.
- B. Coat factory primed hardware items.
- C. Coat surfaces and elements, unless otherwise indicated that are exposed to view from roof level.
- D. Coat exterior structural steel, miscellaneous metal fabrications, metal ladders, and other exterior metals not otherwise pre-finished, unless otherwise indicated.

3.4 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification 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.
- C. Clean substrates of substances that could impair bond of coatings, 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 coating systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
 - 1. Clean surfaces with pressurized water. Use pressure range of 1500 to 4000 psi.
- E. Masonry Substrates: Remove efflorescence and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces or if alkalinity of mortar joints exceed that permitted in manufacturer's written instructions.
 - 1. Clean surfaces with pressurized water. Use pressure range of 1500 to 4000 psi at 6 to 12 inches.
- F. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:
 - 1. Shop Surface Preparation - SSPC-SP 6/NACE No. 3 Commercial Blast Cleaned Steel.
 - 2. Field Surface Preparation - SSPC-SP 11, "Power Tool Cleaning to Bare Metal with a (1) mil surface profile. Use a needle gun, MBX Bristle Blaster or equal equipment.
- G. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied coatings.
 - 1. Shop Surface Preparation: SSPC SP16 Brush-Off Blast Cleaning, done in accordance with ASTM D 6386-99 20-50 psi at the blast nozzle using a fine blasting medium designed not to damage the galvanize metal surface. At any point where galvanized coating is absent or rust is present, prepare as indicated for steel substrate.
 - 2. At any point where galvanized coating is absent or rust is present, prepare as indicated for steel substrate.

- H. Aluminum Substrates: Remove loose surface oxidation. SSPC SP3 Power Tool Cleaning. Uniformly abrade the surface to increase surface adhesion of the HPC.

3.5 APPLICATION

- A. Apply high performance coating to every new and existing exposed exterior surface that is not otherwise pre-finished or with a natural finish.
 - 1. Surfaces at the existing historic courthouse are scheduled for recoating in Section 090190.
 - 2. Stucco is scheduled for coating with mineral silicate coating in Section 099726.
- B. Apply high performance coating to prefinished or naturally finished surfaces where indicated.
- C. Apply high-performance coatings according to manufacturer's written instructions.
 - 1. Use applicators and techniques suited for coating and substrate indicated.
 - 2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 - 4. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- D. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- E. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.
- F. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.
- G. At existing surfaces, spot prime where existing coating is worn through to substrate.

3.6 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test coatings for dry film thickness.
 - 1. Contractor shall touch up and restore coated surfaces damaged by testing.
 - 2. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written recommendations, Contractor shall pay for testing

and apply additional coats as needed to provide dry film thickness that complies with coating manufacturer's written recommendations.

3.7 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, 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 coated surfaces.

3.8 EXTERIOR HIGH-PERFORMANCE COATING SCHEDULE

A. Steel Substrates:

1. Pigmented Polyurethane over Urethane Zinc-Rich Primer System:

- a. Prime Coat: Tnemec Series 90-97 Tneme-Zinc, Zinc-Zich, Moisture-Cured Urethane with 83% Zinc Content at 2.5 to 3.5 mils DFT
- b. Intermediate Coat: Tnemec Series V69/V69F Hi-Build Epoxoline II at 2.5 to 3.5 mils DFT
- c. Topcoat: Tnemec Series 1080-gloss or 1081-semi-gloss, Aliphatic Acrylic Polyurethane, Two-Component, Pigmented, semi-gloss or eggshell finish at 3.0 to 4.0 mils DFT

B. Galvanized-Metal Substrates:

1. Pigmented Polyurethane over Epoxy Primer System:

- a. Prime Coat: Tnemec Series V69/V69F Hi-Build Epoxoline II at 2.5 to 3.5 mils DFT
- b. Topcoat: Tnemec Series 1080-gloss or 1081-semi-gloss, Aliphatic Acrylic Polyurethane, Two-Component, Pigmented, semi-gloss or eggshell finish at 3.0 to 4.0 mils DFT

C. Aluminum (Not Anodized or Otherwise Coated) Substrates:

1. Pigmented Polyurethane System over Epoxy Primer System:

- a. Prime Coat: Tnemec Series V69/V69F Hi-Build Epoxoline II at 2.5 to 3.5 mils DFT
- b. Topcoat: Tnemec Series 1080-gloss or 1081-semi-gloss,, Aliphatic Acrylic Polyurethane, Two-Component, Pigmented, semi-gloss or eggshell finish at 2.5 to 3.0 mils DFT

D. Gypsum Board and Plaster Substrates:

1. Pigmented Polyurethane System:

- a. Prime Coat: Tnemec Series 151-1051 Elasto-Grip at 1.0 to 1.5 mils DFT
- b. Intermediate Coat: Tnemec Series V69/V69F Hi-Build Epoxoline II at 2.5 to 3.5 mils DFT
- c. Topcoat: Tnemec Series 1080-gloss or 1081-semi-gloss,, Aliphatic Acrylic Polyurethane, Two-Component, Pigmented, Finish at 2.5 to 3.0 mils DFT

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SECTION 09 96 46

INTUMESCENT PAINTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes surface preparation and application of fire-retardant intumescent paint.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
1. Product List: Cross-reference to coating system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include manufacturer's recommended spreading rate for each separate coat for each type of substrate indicated.
 2. Printout of current "MPI Approved Products List" for each product category specified in Part 2 that specifies coatings approved by MPI, with the proposed product highlighted.
- B. Samples for Verification: For each type of coating system and each color and gloss of intumescent paint finish indicated.
1. Submit Samples on rigid backing, not less than 8 inches square.
 2. Step coats on Samples to show each coat required for system.
 3. Label each coat of each Sample.
 4. Label each Sample for location and application area.

1.3 INFORMATIONAL SUBMITTALS

- A. Material Test Reports: For each intumescent paint.

1.4 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. Flame-Spread Index: 25 or less.
 2. Smoke-Developed Index: 450 or less.
- B. MPI Standards: Comply with indicated requirements for the following:
1. Wall Surfaces: Prepare Samples of at least 100 sq. ft.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.6 PROJECT CONDITIONS

- A. Apply waterborne intumescent paints only when temperatures of surfaces to be painted and ambient air temperatures are between 50 and 90 deg F.
- B. Apply solvent-thinned intumescent paints only when temperatures of surfaces to be painted and ambient air temperatures are between 45 and 95 deg F.
- C. Do not apply intumescent paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
- D. Allow wet surfaces to dry thoroughly and to attain temperature and conditions specified before starting or continuing coating operation.

PART 2 - PRODUCTS

2.1 INTUMESCENT PAINT MATERIALS, 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 material or coat, provide products and spreading rates recommended in writing by intumescent paint manufacturer for use on substrate indicated. Comply with requirements for fire-retardant coating classification and surface-burning characteristics indicated.
- B. Colors and Gloss: As selected by Architect from manufacturer's full range.

2.2 INTERIOR, PIGMENTED, INTUMESCENT PAINT SYSTEM

- A. Primer: Intumescent paint manufacturer's recommended primer compatible with substrate and other materials indicated.
 - 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. Albi Manufacturing, a division of StanChem, Inc.; primer approved by Albi.
 - b. Benjamin Moore & Co.; Fresh Start 217 Alkyd Enamel Underbody or Super Spec C245 Alkyd Enamel Undercoater/Primer Sealer.

- c. Fire Research Laboratories/Ocean Fire Retardants Inc.; latex primer approved by manufacturer.
 - d. International Fire Resistant Systems, Inc.; primer approved by manufacturer.
 - e. Magna Coatings Technology Inc.; SafeCoat 725 Sealer/Overcoat.
 - f. PPG Industries, Inc.; Speed Hide 6-6 interior quick-drying enamel undercoater.
- B. Topcoat/Overcoat: Water-based, latex-type, pigmented, fire-inert, protective-finish coating that will not affect fire-retardant class of intumescent coating.
 - 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. Albi Manufacturing; a division of StanChem, Inc.; Albi-Cote TC Latex Semi Gloss.
 - b. Flame Control Coatings, LLC; No. 40-40; low gloss finish.
 - c. Benjamin Moore & Co.; no coating permitted.
 - d. Magna Coatings Technology Inc.; no coating recommended.
 - e. Muralo Company (The); no coating required.
 - f. NoFire Technologies, Inc.; latex-based coating approved by NoFire.
 - g. PPG Industries, Inc.; no coating recommended.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with manufacturer's requirements for surface treatments, shop-primed surfaces, maximum moisture content, and other conditions affecting performance of the Work.
- B. Begin coating no sooner than 28 days after substrate is constructed and is visually dry on both sides.
- C. Verify suitability of substrates, including surface conditions, and compatibility with existing finishes and primers.
- D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.

3.2 PREPARATION

- A. Preparation: Comply with manufacturer's written instructions and recommendations in the "MPI Architectural Painting Specification Manual" applicable to substrates and coating systems indicated.
- B. Remove hardware and hardware accessories, plates, machined surfaces, light fixtures, and similar items already installed that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
 - 1. After completing coating operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

- C. Clean substrates of substances, including dirt, oil, grease, and incompatible paints and encapsulants, that could impair bond of coatings. Do not coat surfaces if surface moisture content or alkalinity exceeds that permitted in manufacturer's written instructions.
 - 1. Remove incompatible primers, and reprime substrate with compatible primers as required to produce coating systems indicated.
 - 2. Perform cleaning and coating application so dust and other contaminants from cleaning process will not fall on wet, newly coated surfaces.

3.3 APPLICATION

- A. General: Apply intumescent paints according to manufacturer's written instructions and to comply with requirements for fire-retardant coating classification.
 - 1. Use equipment and techniques best suited for substrate and type of material being applied.
 - 2. Coat surfaces behind movable items the same as similar exposed surfaces.
 - 3. Apply each coat separately according to manufacturer's written instructions.
- B. Apply coatings to prepared surfaces as soon as practical after preparation and before subsequent surface soiling or deterioration.
- C. Apply coatings 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.
 - 1. Pigmented Finishes: If undercoats or other conditions show through pigmented topcoat/overcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

3.4 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from coating 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, touch up and restore damaged or defaced coated surfaces.

3.5 PAINT SYSTEM SCHEDULE

- A. Prime Coat: If required and approved by intumescent paint manufacturer.

- B. Fire-Retardant Intumescent Coating: Minimum two coats to comply with requirements for fire-retardant coating classification and surface-burning characteristics indicated.
- C. Topcoat/Overcoat: Apply if required or recommended and approved by intumescent paint manufacturer.

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SECTION 09 97 26
MINERAL SILICATE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes surface preparation and application of mineral silicate cementitious coating systems on the following substrates:
 - 1. Exterior Portland Cement Stucco.
 - 2. Where otherwise indicated.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Initial Selection: For each type of topcoat product.
- C. Samples for Verification: In each color and gloss of topcoat.
 - 1. Submit Samples on **rigid backing**, not less than **12 inches** square.
 - 2. Apply coats on Samples in steps to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.

1.3 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For each cementitious coating, from manufacturer.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency or performed by a qualified testing agency, for each product formulation.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that are from same production run (batch mix) as materials applied and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Quantity: Furnish an additional 5 percent of each color applied.

1.5 QUALITY ASSURANCE

- A. Mockups: Apply mockups of coating 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 actual substrate of each type to represent surfaces and conditions for application of coating.
 - a. Wall Surfaces: Prepare Samples of at least **100 sq. ft.**
 - 2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of colors selected by Architect at no added cost to Owner.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in manufacturer's original, new, unopened packages and containers bearing manufacturer's name and label, and the following information:
 - 1. Product name or title of material.
 - 2. Manufacturer's stock number and date of manufacture.
 - 3. Contents by volume, for pigment and vehicle constituents.
 - 4. Application instructions.
 - 5. Color name and number.
 - 6. Handling instructions and precautions.
- B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of **45 deg F**. Maintain containers used in storage of coatings in a clean condition, free of foreign materials and residue.
 - 1. Protect cementitious coating materials from freezing. Keep materials dry and storage area neat and orderly. Remove waste daily. Take necessary measures to ensure that workers and work areas are protected from health hazards resulting from handling, mixing, and applying the coating.

1.7 FIELD CONDITIONS

- A. Apply coatings only when temperature of surfaces to be painted and ambient air temperatures are between **50 and 95 deg F**.
- B. Do not apply coatings 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. Products: Subject to compliance with requirements, **available products that may be incorporated into the Work include, but are not limited to products** listed in the Cementitious Coating Schedule for the paint category indicated.
- B. Source Limitations: Obtain cementitious coating materials from single source and from single manufacturer.
- C. Colors: **Match Architect's samples.**
- D. Other Materials: Provide crack fillers, block fillers, and related materials that are compatible with cementitious finish-coat materials and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Verify suitability of substrates, including surface conditions and compatibility.
- C. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
 - 1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions for mixing and preparing materials and as applicable to substrates indicated.
- B. Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
 - 1. After completing coating operations, 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 coatings, including dirt, oil, grease, incompatible coatings, and loose substrate materials.
- D. Cementitious and Masonry Surfaces: 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. Crack Repair: Fill cracks according to manufacturer's written instructions before coating surfaces.
 - 1. Cracks Larger Than **1/32 Inch**: Cut out static cracks, voids, or honeycombing larger than **1/32 inch** and patch with materials recommended in writing by coating manufacturer. Identify dynamic cracks and treat according to manufacturer's written instructions before beginning application.

3.3 APPLICATION

- A. Apply coatings according to manufacturer's written instructions. Use applicators and techniques suited for coating and substrate indicated.
 - 1. Dampen substrate of surfaces to receive cementitious coatings one hour before beginning application to prevent surface drag. Immediately before applying coatings, redampen substrate. Substrates shall be saturated and surface dry at time of application.
 - 2. Brushes: Use Tampico or masonry brushes best suited for material being applied.
 - 3. Spray Equipment: Use spray equipment recommended in writing by manufacturer for material and texture required.
- B. Apply coating to achieve material thickness as recommended in writing by manufacturer, but not less than the following:
 - 1. First Coat: Apply polymer-modified cementitious coating material at the rate of **2 lb/sq. yd.** to achieve a total cured thickness of **25 mils.**
 - 2. Second Coat: Apply polymer-modified cementitious coating material at the rate of **1 lb/sq. yd.** to achieve a total cured thickness of **15 mils.**
 - 3. Apply additional coats when undercoats or other conditions show through final coat until cured film is of uniform coating finish, color, and appearance.
- C. On previously coated surfaces, apply coating to achieve material thickness as recommended in writing by manufacturer, but not less than the following:
 - 1. Apply polymer-modified cementitious coating material at the rate of **1 lb/sq. yd.** to achieve a total cured thickness of **15 mils.**
 - 2. Apply additional coats when undercoats or other conditions show through final coat until cured film is of uniform coating finish, color, and appearance.

- D. Brush Application: Brush out and work brush coats into surfaces in an even film, filling all pores and voids at rate recommended in writing by manufacturer to achieve cured material thickness indicated. Finish coat with smooth, horizontal strokes.
- E. Spray Application: Apply each coat according to manufacturer's written instructions to provide the equivalent hiding of brush-applied coats. Follow spray application with a general light brooming of coated surface to impart a slight texture.

3.4 FIELD QUALITY CONTROL

- A. Testing of Coating Materials: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when coating operations are being conducted:
 - 1. Owner may engage the services of a qualified testing agency to sample coating materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
 - 2. Testing agency will perform tests for compliance with product requirements specified.
 - 3. Owner may direct Contractor to stop coating application if test results show materials being used do not comply with requirements. Contractor shall remove noncomplying materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from coating 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 coated surfaces.

3.6 CEMENTITIOUS COATING SCHEDULE

- A. Products listed by Keim
- B. New Stucco or Plaster:

1. Cleaner: Lime Remover/Etchant.
 2. Coating: Two coats Soldalit Sol Silicate All Surface Finish.
- C. Existing Stucco or Plaster:
1. Cleaner:
 - a. Biological growth stains: Bio Cleaner.
 - b. Stains and contaminants: HD Cleaner.
 2. Patching compound: Masonry Spackle.
 3. Primer: Contact Plus Sanded Primer.
 4. Coating: Two coats Soldalit Sol Silicate All Surface Finish.

END OF SECTION

SECTION 09 97 33
CONCRETE FLOOR SEALER

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
1. Concrete sealer for cured concrete floors.

1.2 ACTION SUBMITTALS

- A. Product Data: Provide data on specified products, describing physical and performance characteristics.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Accept concrete sealer on site in manufacturer original unopened containers. Inspect for damage.
- B. Protect concrete sealer from freezing.

1.4 ENVIRONMENTAL REQUIREMENTS

- A. Do not install concrete sealer when air temperature or concrete surface temperature is less than 40 degrees F.
- B. Maintain concrete floor surface temperature above freezing during and after installation of concrete sealer until sealer is cured.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Curecrete Chemical Company; Ashford Formula.
 2. The Euclid Chemical Company; Euco Diamond Hard.
 3. L&M Construction Chemicals, Inc.; Seal Hard.
 4. PROSOCO; Consolideck LS.
- B. Concrete Sealer: Clear, penetrating, reactive VOC compliant, waterborne silicate compound designed to densify and seal concrete surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify floor surfaces are free of substances that may impair penetration of concrete sealer.

3.2 PREPARATION

- A. Remove membrane forming curing compounds and other surface contaminants capable of impairing concrete sealer penetration into concrete.
- B. Remove contaminants by chemical or mechanical means as recommended by concrete sealer manufacturer.
- C. Allow floor to dry. Broom clean floor surface to remove loose dust and dirt.

3.3 INSTALLATION

- A. Apply concrete sealer in accordance with manufacturer instructions.
- B. Keep floor surface wet with concrete sealer for minimum 30 minutes.
- C. Scrub concrete sealer into concrete surface with mechanical scrubbers.
- D. Remove excess liquid material from floor surface.
- E. Rinse floor when required to remove excess concrete sealer.

3.4 PROTECTION OF FINISHED WORK

- A. Prohibit traffic on floor finish for 8 hours after installation.

3.5 CLEANING

- A. Remove concrete sealer residue from floor surface.

END OF SECTION

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SECTION 10 21 13.14

STAINLESS-STEEL TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Stainless steel toilet compartments configured as toilet enclosures and urinal screens.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for 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 reinforcements for compartment-mounted grab bars and locations of blocking for surface-mounted toilet accessories.
4. Show locations of centerlines of toilet fixtures.
5. Show locations of floor drains.

C. 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 toilet compartments, prepared on 6-inch- (152-mm-) square Samples of same thickness and material indicated for Work.
2. Each type of hardware and accessory.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of toilet compartment.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For toilet compartments to include in maintenance manuals.

1.5 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 STAINLESS STEEL TOILET COMPARTMENTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Accurate Partitions Corporation.
 2. Bradley Corporation; Mills Partitions.
 3. Global Steel Products Corp.
 4. Knickerbocker Partition Corporation.
- B. Toilet-Enclosure Style: Overhead braced.
- C. Urinal-Screen Style: Wall hung flat panel.
- D. Door, Panel, and Pilaster Construction: Seamless, metal facing sheets pressure laminated to core material; with continuous, interlocking molding strip or lapped-and-formed edge closures; corners secured by welding or clips and exposed welds ground smooth. Provide with no-sightline system. Exposed surfaces shall be free of pitting, seam marks, roller marks, stains, discolorations, telegraphing of core material, or other imperfections.
1. Core Material: Manufacturer's standard sound-deadening honeycomb of resin-impregnated kraft paper in thickness required to provide finished thickness of 1 inch (25 mm) for doors and panels and 1-1/4 inches (32 mm) for pilasters.
 2. Grab-Bar Reinforcement: Provide concealed internal reinforcement for grab bars mounted on units of size and material adequate for panel to withstand applied downward load on grab bar of at least 250 lbf (1112 N), when tested according to ASTM F446, without deformation of panel.
 3. Tapping Reinforcement: Provide concealed reinforcement for tapping (threading) at locations where machine screws are used for attaching items to units.
- E. Urinal-Screen Construction:
1. Flat-Panel Urinal Screen: Matching panel construction.
- F. Facing Sheets and Closures: Stainless-steel sheet of nominal thicknesses as follows:
1. Pilasters, Braced at Both Ends: Manufacturer's standard thickness, but not less than 0.038 inch (0.95 mm).
 2. Pilasters, Unbraced at One End: Manufacturer's standard thickness, but not less than 0.050 inch (1.27 mm).
 3. Panels: Manufacturer's standard thickness, but not less than 0.031 inch (0.79 mm).
 4. Doors: Manufacturer's standard thickness, but not less than 0.031 inch (0.79 mm).
 5. Flat-Panel Urinal Screens: Thickness matching the panels.

- G. Pilaster Shoes: Stainless steel sheet, not less than 0.031-inch (0.79-mm) nominal thickness and 3 inches (76 mm) high, finished to match hardware.
- H. Brackets (Fittings):
 - 1. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel.
- I. Stainless Steel Finish: ASTM A480/A480M No. 4 bright, directional polish on exposed faces. Protect exposed surfaces from damage by application of strippable, temporary protective covering before shipment.

2.3 HARDWARE AND ACCESSORIES

- A. Hardware and Accessories: Manufacturer's heavy-duty operating hardware and accessories.
 - 1. Hinges: Manufacturer's minimum 0.062-inch- (1.59-mm-) thick stainless steel paired, self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees, allowing emergency access by lifting door. Mount with through-bolts.
 - 2. Latch and Keeper: Manufacturer's heavy-duty surface-mounted cast-stainless steel latch unit designed to resist damage due to slamming, with combination rubber-faced door strike and keeper, and with provision for emergency access. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible. Mount with through-bolts.
 - 3. Coat Hook: Manufacturer's heavy-duty combination cast-stainless steel hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories. Mount with through-bolts.
 - 4. Door Bumper: Manufacturer's heavy-duty rubber-tipped cast-stainless steel bumper at out-swinging doors. Mount with through-bolts.
 - 5. Door Pull: Manufacturer's heavy-duty cast-stainless steel pull at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible. Mount with through-bolts.
- B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.
- C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match 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 anchors compatible with related materials.

2.4 MATERIALS

- A. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, stretcher-leveled standard of flatness.
- B. Stainless Steel Castings: ASTM A743/A743M.

2.5 FABRICATION

- A. Fabrication, General: Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories and solid blocking within panel where required for attachment of toilet accessories.
- B. 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.
- C. Door Size and Swings: Unless otherwise indicated, provide 24-inch- (610-mm-) wide in-swinging doors for standard toilet compartments and 36-inch- (914-mm-) wide out-swinging doors with a minimum 32-inch- (813-mm-) wide clear opening for compartments 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 (13 mm).
 - b. Panels and Walls: 1 inch (25 mm).
 - 2. Full-Height (Continuous) Brackets: Secure panels to walls and to pilasters with full-height brackets.
 - a. Locate bracket fasteners 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 (44 mm) 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.

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SECTION 10 26 00

WALL AND DOOR PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Corner guards.
 - 2. Abuse-resistant wall coverings.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For each type of wall protection, showing locations and extent.
- C. Samples for Verification: For each type of exposed finish on the following products, prepared on Samples of size indicated below:
 - 1. Corner Guards: 12 inches (300 mm) long. Include example top caps.
 - 2. Abuse-Resistant Wall Covering: 6 by 6 inches (150 by 150 mm) square.

1.3 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For each type of exposed plastic material.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of wall protection product to include in maintenance manuals.
 - 1. Include recommended methods and frequency of maintenance for maintaining best condition of plastic covers under anticipated traffic and use conditions. Include precautions against using cleaning materials and methods that may be detrimental to finishes and performance.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store wall protection 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 (21 deg C) during the period plastic materials are stored.
 - 2. Keep plastic materials out of direct sunlight.
 - 3. Store plastic wall protection components for a minimum of 72 hours, or until plastic material attains a minimum room temperature of 70 deg F (21 deg C).
 - a. Store corner-guard covers in a vertical position.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface Burning Characteristics: Comply with ASTM E84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 450 or less.

2.2 CORNER GUARDS

- A. Manufacturers and Products: See Finish Legend on Drawings for Basis of Design products, sizes, and colors.
 - 1. Substitution Requests: Substitution Requests require a full sample of the corner guard to be dropped off at the Architect's office below. See Specification 012500 "Substitution Procedures" for additional information.
 - a. Tevebaugh Architecture
Two Mill Road, Suite 210
Wilmington, DE 19806.

2.3 ABUSE-RESISTANT WALL COVERINGS

- A. Manufacturers and Products: See Finish Legend on Drawings for Basis of Design products, sizes, and colors.
 - 1. Substitution Requests: Substitution Requests require a full sample of the product to be dropped off at the Architect's office below. See Specification 012500 "Substitution Procedures" for additional information.
 - a. Tevebaugh Architecture
Two Mill Road, Suite 210
Wilmington, DE 19806.

2.4 FABRICATION

- A. Fabricate wall and door protection according to requirements indicated for design, performance, dimensions, and member sizes, including thicknesses of components.
- B. Factory Assembly: Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.
- C. Quality: Fabricate components with uniformly tight seams and joints and 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.

2.5 FINISHES

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

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances, fire rating, and other conditions affecting performance of the Work.
- B. Examine walls to which wall and door 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.
 - 1. For wall and door protection attached with adhesive, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Complete finishing operations, including painting, before installing wall and door protection.
- B. Before installation, clean substrate to remove dust, debris, and loose particles.

3.3 INSTALLATION

- A. Installation Quality: Install wall and door protection according to manufacturer written instructions, level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.

- B. Mounting Heights: Install wall and door protection in locations and at mounting heights indicated on Drawings.
- C. Accessories: Provide splices, mounting hardware, anchors, trim, joint moldings, and other accessories required for a complete installation.
 - 1. Provide anchoring devices and suitable locations to withstand imposed loads.
 - 2. Where splices occur in horizontal runs of more than 20 feet (6.1 m), splice aluminum retainers and plastic covers at different locations along the run, but no closer than 12 inches (305 mm) apart.
 - 3. Adjust top caps as required to ensure tight seams.
- D. Abuse-Resistant Wall Covering: Install top and edge moldings, corners, and divider bars as required for a complete installation.

3.4 CLEANING

- A. Immediately after completion of installation, clean plastic covers and accessories using a standard ammonia-based household cleaning agent.
- B. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION

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SECTION 10 28 00

TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Public-use washroom accessories.

1.2 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
3. Include electrical characteristics.

B. Samples: For each exposed product and for each finish specified, full size.

1. Approved full-size Samples will be returned and may be used in the Work.

C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.

1. Identify locations using room designations indicated.
2. Identify accessories using designations indicated.

D. Delegated-Design Submittal: For grab bars.

1. Include structural design calculations indicating compliance with specified structural-performance requirements.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For manufacturer special warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For accessories to include in maintenance manuals.

1.6 WARRANTY

- A. Manufacturer Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, visible silver spoilage defects.
 - 2. Warranty Period: Ten years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Structural Performance: Design accessories and fasteners to comply with the following requirements:
 - 1. Grab Bars: Installed units are able to resist 250 lbf (1112 N) concentrated load applied in any direction and at any point.

2.2 PUBLIC-USE WASHROOM ACCESSORIES

- A. Manufacturers and Products: See Drawings for Basis of Design products, sizes, and colors.
 - 1. Substitution Requests: Substitution Requests require a full sample of each accessory to be dropped off at the Architect's office below. See Specification 012500 "Substitution Procedures" for additional information.
 - a. Tevebaugh Architecture
Two Mill Road, Suite 210
Wilmington, DE 19806.

2.3 MATERIALS

- A. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, 0.031-inch- (0.8-mm-) minimum nominal thickness unless otherwise indicated.
- B. Brass: ASTM B19, flat products; ASTM B16/B16M, rods, shapes, forgings, and flat products with finished edges; or ASTM B30, castings.

- C. Steel Sheet: ASTM A1008/A1008M, Designation CS - cold rolled, commercial steel, 0.036-inch- (0.9-mm-) minimum nominal thickness.
- D. Galvanized-Steel Sheet: ASTM A653/A653M, with G60 (Z180) hot-dip zinc coating.
- E. Galvanized-Steel Mounting Devices: ASTM A153/A153M, hot-dip galvanized after fabrication.
- F. Fasteners: Screws, bolts, and other devices of same material as accessory unit, unless otherwise recommended by manufacturer or specified in this Section, and tamper and theft resistant where exposed, and of stainless or galvanized steel where concealed.
- G. Chrome Plating: ASTM B456, Service Condition Number SC 2, moderate service.
- H. Mirrors: ASTM C1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.4 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.
 - 1. Remove temporary labels and protective coatings.
- B. Grab Bars: Install to comply with specified structural-performance requirements.

3.2 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Clean and polish exposed surfaces according to manufacturer written instructions.

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SECTION 10 44 13
FIRE PROTECTION CABINETS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fire-protection cabinets for the following:
 - a. Portable fire extinguisher.

1.2 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.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. 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.
 - 1. Include plans, elevations, sections, details, and attachments to other work.
- C. Samples: For each type of exposed finish required.
- D. Samples for Verification: For each type of exposed finish required, prepared on samples 6 by 6 inches (150 by 150 mm) square.
- E. 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.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For fire-protection cabinets to include in maintenance manuals.

1.5 COORDINATION

- A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
- B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain fire-protection cabinets, accessories, and fire extinguishers from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E814 for fire-resistance rating of walls where they are installed.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 FIRE-PROTECTION CABINET

- A. Cabinet Type: Suitable for fire extinguisher.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. JL Industries, Inc.; a division of the Activar Construction Products Group.
 - b. Larsens Manufacturing Company.
 - c. Nystrom, Inc.
 - d. Potter Roemer LLC.
- B. Cabinet Construction: Nonrated, One-hour fire rated, and Two-hour fire rated.
 - 1. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.043-inch- (1.09-mm-) thick cold-rolled steel sheet lined with minimum 5/8-inch- (16-mm-) thick fire-barrier material. Provide factory-drilled mounting holes.
- C. Cabinet Material: Cold-rolled steel sheet.
 - 1. Shelf: Same metal and finish as cabinet.
- D. Recessed Cabinet:
 - 1. Trimless with Concealed Flange: Surface of surrounding wall finishes flush with exterior finished surface of cabinet frame and door, without overlapping trim attached to cabinet. Provide recessed flange, of same material as box, attached to box, to act as drywall bead.

- E. Semirecessed Cabinet: One-piece combination trim and perimeter door frame overlapping surrounding wall surface, with exposed trim face and wall return at outer edge as backbend.
 - 1. Rolled-Edge Trim: 2-1/2-inch (64-mm) backbend depth.
- F. Door Material: Steel sheet or Aluminum sheet.
- G. Door Style: Fully glazed panel with frame.
- H. Door Glazing: Tempered float clear glass clear.
- I. Door Hardware: Manufacturer standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
 - 1. Provide manufacturer standard pull and latching.
 - 2. Provide manufacturer standard hinge, permitting door to open 180 degrees.
- J. Accessories:
 - 1. Mounting Bracket: Manufacturer 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. Lettered Door Handle: One-piece, cast-iron door handle with the word "FIRE" embossed into face.
 - 3. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as directed by Architect.
 - a. Identify fire extinguisher in fire-protection cabinet with the words " FIRE EXTINGUISHER."
 - 1) Location: Applied to location indicated on Drawings.
 - 2) Application Process: Pressure-sensitive vinyl letters.
 - 3) Lettering Color: Red.
 - 4) Orientation: See Drawings.
- K. Materials:
 - 1. Cold-Rolled Steel: ASTM A1008/A1008M, Commercial Steel (CS), Type B.
 - a. Finish: Factory primed for field painting.
 - b. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - c. Color: Match Architect's sample.
 - 2. Aluminum: ASTM B221/B221M for extruded shapes and aluminum sheet, with strength and durability characteristics of not less than Alloy 6063-T5 for aluminum sheet.
 - a. Finish: Clear anodic.
 - 3. Tempered Float Glass: ASTM C1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick Class 1 (clear).

2.4 FABRICATION

- A. Fire-Protection Cabinets: Provide manufacturer standard box/tub with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
 - 1. Weld joints and grind smooth.
 - 2. Miter corners and grind smooth.
 - 3. Provide factory-drilled mounting holes.
- B. Cabinet Doors: Fabricate doors according to manufacturer standards, from materials indicated and coordinated with cabinet types and trim styles.
- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.5 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
- C. Finish fire-protection cabinets after assembly.
- D. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls and partitions for suitable framing depth and blocking where recessed and semirecessed cabinets will be installed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare recesses for recessed and semirecessed fire-protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

- A. General: Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.

- B. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.
 - 1. Unless otherwise indicated, provide recessed fire-protection cabinets. If wall thickness is inadequate for recessed cabinets, provide semirecessed fire-protection cabinets.
 - 2. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.
- C. Identification:
 - 1. Apply vinyl lettering at locations indicated.
 - 2. Apply vinyl lettering on field-painted fire-protection cabinets after painting is complete.

3.4 ADJUSTING AND CLEANING

- A. Remove temporary protective coverings and strippable films, if any, as fire-protection cabinets are installed unless otherwise indicated in manufacturer 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.

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SECTION 10 44 16

FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

1.2 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.

1.3 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.5 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.6 WARRANTY

- A. Special Warranty: Manufacturer standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure of hydrostatic test according to NFPA 10 when testing interval required by NFPA 10 is within the warranty period.
 - b. Faulty operation of valves or release levers.
 - 2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
 - 1. Provide fire extinguishers approved, listed, and labeled by FM Global.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Amerex Corporation.
 - b. JL Industries, Inc.; a division of the Activar Construction Products Group.
 - c. Larsens Manufacturing Company.
 - d. Potter Roemer LLC.
 - 2. Source Limitations: Obtain fire extinguishers, fire-protection cabinets, and accessories, from single source from single manufacturer.
 - 3. Valves: Manufacturer standard.
 - 4. Handles and Levers: Manufacturer standard.
 - 5. 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 2-A:10-B:C, 5-lb (2.3-kg) nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

2.3 MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer standard galvanized 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 or black baked-enamel finish.
 - 1. Source Limitations: Obtain mounting brackets and fire extinguishers from single source from single manufacturer.
- B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
 - 1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
 - 1. Mounting Brackets: Top of fire extinguisher to be at 42 inches (1067 mm) above finished floor.
- B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION

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SECTION 10 82 13
METAL SCREEN WALL

PART 1 - GENERAL

1.1 SUMMARY

A. SECTION INCLUDES

1. Metal Screen Wall panels to form exterior rooftop screen assembly.
2. Sub-framing supporting metal screen wall panels mounted on structural steel framing.
3. Trim at metal screen wall.

B. RELATED REQUIREMENTS

1. Section 01 83 16 "Exterior Enclosure General Requirements" for additional requirements related to the building enclosure including but not limited to:
 - a. Performance and design requirements for the exterior building enclosure.
 - b. Coordination of Work required to complete the Exterior Enclosure.
 - c. Quality Assurance and Control procedures required for the work of the Exterior Enclosure.
 - d. Independent inspection and testing required to verify performance of the work of this section.
2. Division 05 Section 05 12 00 "Structural Steel Framing" for primary structural members supporting metal screen wall system.
3. Section 07 42 15 "Insulated Metal Panels" for adjacent panels enclosing roof penthouse.

1.2 QUALITY ASSURANCE

- A. Manufacturer Qualifications:** A manufacturer capable of fabricating metal wall panels that meet or exceed performance requirements indicated and of documenting this performance by certification, labeling, and inclusion in lists.

1. Experience: Minimum five (5) years producing products similar to those required for this Project. Provided products for three (3) projects of scope, schedule and complexity similar to this Project within last two (2) years as acceptable to Architect.
2. Certify compliance. Include project descriptions with Owner and Design Professional contacts for previous experience and resume for designer.

- B. Single Source Requirements: Products shall be supplied by one (1) manufacturer. Accessory products including, for example, fasteners, sealants and anchors may be from other than primary manufacturer if approved in writing by primary manufacturer and Architect.
- C. Delegated Design Engineer: Professional Engineer, licensed in State of Delaware and having a minimum of five (5) years documented experience designing systems similar to those required for this Project. Delegated Design Engineer shall sign and seal calculations.
- D. Installer/Fabricator Qualifications: Manufacturer's authorized representative who is trained and approved for fabrication and installation of metal wall panels required for this Project.
 - 1. Experience: Minimum five (5) years fabricating and installing products similar to those required for this Project.
 - 2. Completed three (3) projects of scope, schedule and complexity similar to this Project using systems similar to those required for this Project within last two (2) years as acceptable to Architect.
 - 3. Adequately trained by manufacturer and recommended in writing by manufacturer for type of fabrication and installation required for this Project.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct preinstallation meeting at site attended by Owner, Architect, manufacturer's representative, and other trade contractors.
 - 1. Coordinate building framing [and secondary framing] in relation to metal wall panel assembly.

1.4 SUBMITTAL REQUIREMENTS

- A. Submit per the requirements of Section 01 33 00 Submittal Procedures and as indicated herein.
- B. CM shall coordinate submittals as indicated in 018316 Paragraph 1.3-C and as otherwise indicated.
- C. Submit a single package including the following:
 - 1. Product data
 - 2. Shop drawings
 - 3. Delegated design submittal.
 - 4. Qualification data
 - 5. Product test reports
 - 6. Manufacturers certificates

7. Fabricator/Installer certificates and qualifications
8. Installation instructions
9. Sample Warranties

- D. Submittal packages that do not include the full list below shall be rejected without action.

1.5 ACTION SUBMITTALS

- A. Product Data: Manufacturer's data sheets, for specified products.
1. Include data indicating compliance with performance requirements.
- B. Shop Drawings: Provide shop drawings prepared by manufacturer or manufacturer's authorized Installer. Include full elevations showing openings and penetrations. Include details of each condition of installation and attachment. Provide details at a minimum scale 3-inch per foot (1:4) of all required trim and extrusions needed for a complete installation.
1. Indicate points of supporting structure that must coordinate with metal wall panel assembly installation.
 2. Note locations where separation of dissimilar materials is required and indicate method to be used.
 3. Indicate adjacent material types and methods to be used to prevent staining effect on metal wall panels caused by water runoff.

1.6 DELEGATED DESIGN SUBMITTALS

- A. Delegated-Design Submittal: For wall panel system, include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Calculation sheets shall be cross-referenced to the exact shop drawing page number and detail for the assembly being analyzed.
 2. Anchors: Include analysis of the anchors which attach the systems to adjacent construction or structure. Analyze and identify every anchor, bolt, screw, clip, fastener or similar device for fixing the window wall in place. These cannot be indicated as "By others".
 3. Include thermal analysis of movement to be accommodated.

1.7 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Indicating compliance of products with requirements, from a qualified independent testing agency.
- B. Qualification Information: For Installer firm.

- C. Installation instructions.
- D. Manufacturer's warranty: Submit sample warranty.

1.8 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect metal wall panel products during shipping, handling, and storage to prevent staining, denting, deterioration of components or other damage.
 - 1. Deliver, unload, store, and erect metal wall panel products and accessory items without misshaping panels or exposing panels to surface damage from weather or construction operations.

1.10 WARRANTY

- A. Special Manufacturer's Warranty: On manufacturer's standard form, in which manufacturer agrees to repair or replace components of metal wall panel assemblies that fail in materials and workmanship within two years from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: **20** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design wall panels and screen and supporting elements, including comprehensive engineering analysis by a qualified professional engineer, using structural performance requirements and design criteria indicated.
 - 1. Select thickness of material for span along with spacing and thickness of girts to comply with wind loading.
 - 2. Anchors: Include analysis of the anchors which attach the systems to adjacent construction or structure. Analyze and identify every anchor, bolt, screw, clip, fastener or similar device for fixing the window wall in place. These cannot be indicated as "By others".
- B. Comply with performance criteria indicated in Section 01 83 16 "Exterior Enclosure General Requirements" and additional criteria indicated herein.
 - 1. Failure also includes the following:
 - a. Thermal stresses transferring to building structure.
 - b. Noise or vibration created by wind and thermal and structural movements.
 - c. Loosening or weakening of fasteners, attachments, and other components.
- C. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 330:
 - 1. Loads: See Section 01 83 16 and sheet S-001.
- D. Structural Requirements at Design Load:
 - 1. Deflection of any member in a direction normal or perpendicular to plane of wall when subjected to design loads shall not:
 - a. Exceed $L/120$.
 - b. For the face of metal panels deflection shall be limited to eliminate visible oil canning.
- E. Thermal Movements: Allow for thermal movements from variations in both ambient and internal temperatures. Accommodate movement of support structure caused by thermal expansion and contraction.

2.2 ALUMINUM PANELS

- A. Modular metal panel with concealed fastener attachment.

- B. Depth: 1-3/8"
- C. Material: 0.060" thick aluminum
- D. Joint reveals: 3/4" wide.
- E. Basis of Design: Intercept Entyre by Centria
- F. Flat Reinforcement: Reinforce with aluminum angles adhered with VHB tape or structural silicone adhesive at maximum 24" on-center to control oil-canning.
- G. Reinforce to support loading while allowing for movement indicated.

2.3 METAL PANEL ACCESSORIES

- A. Metal Wall Panel Accessories, General: Provide complete metal wall panel assembly incorporating trim, copings, fasciae, parapet caps, sills, inside and outside corners, and miscellaneous flashings. Fabricate accessories in accordance with SMACNA Manual. Provide manufacturer's factory-formed clips, shims, flashings, and caps for a complete installation.
- B. Formed Flashing and Trim: Match material, thickness, finish and color of metal wall panel face sheets.
- C. Fasteners: Self-tapping 300 series stainless steel screws, No. 14 minimum, hex-head, and other acceptable fasteners recommended by panel manufacturer.

2.4 SUB-FRAMING

- A. Sub-framing system: Girts, angles, plates, angles, gussets, and other framing along with clips fixed to structural steel backup, plus shims, anchors, bolts, and fabrication necessary to support IMP.
- B. Fabricate from aluminum or galvanized steel, size to suit loading and as required to support panels.
 - 1. Miscellaneous Metal Subframing and Furring: ASTM C645, cold-formed, metallic-coated steel sheet, ASTM A653/A653M, **G90 hot-dip galvanized** coating designation or ASTM A792/A792M, **Class AZ50** aluminum-zinc-alloy coating designation unless otherwise indicated.

2.5 METAL PANEL FINISHES

- A. Exposed Coil-Coated Finish System:

1. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions

B. Color:

1. Exterior Surface: As selected by Architect from manufacturer's standard colors
2. Interior Surface: As selected by Architect from manufacturer's standard colors.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Framing: Inspect framing that will support metal wall panels to determine if support components are installed as indicated on approved shop drawings. Confirm presence of acceptable framing members at recommended spacing to match installation requirements of metal wall panels.
- B. Openings: Verify that openings and penetrations match layout on shop drawings.
- C. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 METAL PANEL INSTALLATION

- A. General: Install metal wall panels in accordance with approved shop drawings and manufacturer's recommendations. Install metal wall panels in orientation, sizes, and locations indicated. Anchor metal wall panels and other components securely in place.
- B. Attach panels to metal framing using recommended screws, fasteners, sealants, and adhesives indicated on approved shop drawings.
 1. Seal any penetrations into the structural HSS frame.
 2. Provide escutcheons for pipe and conduit penetrating panels.
 3. Dissimilar Materials: Where elements of metal wall panel system will come into contact with dissimilar materials, separate faces and edges in contact with dissimilar materials utilizing non-metallic shims or closed cell foam material at each fastening point as recommended by manufacturer.

3.3 ACCESSORY INSTALLATION

- A. General: Install metal wall panel accessories with positive anchorage to building. Coordinate installation with flashings and other components.
 - 1. Install related flashings and sheet metal trim per requirements of Division 07 Section 07 62 00 "Sheet Metal Flashing and Trim."
 - 2. Install components required for a complete metal wall panel assembly, including trim, copings, corners, and similar items.
 - 3. Comply with performance requirements and manufacturer's written installation instructions.
 - 4. Set units true to line and level as indicated.

3.4 CLEANING AND PROTECTION

- A. Remove temporary protective films. Clean finished surfaces as recommended by metal wall panel manufacturer. Maintain in a clean condition during construction.
- B. Replace damaged panels and accessories that cannot be repaired by finish touch-up or minor repair.

END OF SECTION

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SECTION 11 14 00

PEDESTRIAN CONTROL EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Optical turnstile for bi-directional pedestrian access control.
 - 2. Stanchions.

1.2 ACTION SUBMITTALS

- A. Product data.
- B. Shop Drawings: Indicate pertinent dimensions, general construction, component connections and locations, anchorage methods and locations, hardware, and installation details.
- C. Samples: For each exposed finish, 6 inch square.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance data.

1.5 QUALITY ASSURANCE

- A. Manufacturer to provide a factory-trained supervisor during installation of the security optical turnstile.
- B. Manufacturer to provide a local, factory-trained, field service technician to competently service the security optical turnstile; and to provide for the local support of the customer's service technicians, in the event that the customer's trained technician is not available.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to job site in undamaged manufacturer packaging, complete with installation instructions.
- B. Store off ground, under covered area, protected from weather and construction activities.

1.7 FIELD CONDITIONS

- A. Do not install until finish flooring is complete and dry, and power conduit is supplied.

1.8 WARRANTY

- A. Manufacturer standard material warranty.

PART 2 - PRODUCTS

2.1 OPTICAL TURNSTILES

- A. Motorized optical turnstile: Bi-directional pedestrian access control.
 - 1. Manufacturer and Product: ALVARADO dormakaba Group, SU4500 Compact Optical Turnstile, as basis of design.
 - a. Finish: No. 4 stainless steel.
 - b. Cabinet Lid: No. 4 stainless steel.
 - c. Moving Barrier Panels: 1/2 inch thickness, clear acrylic with abrasion resistant coating.
 - d. Side Panels: 3/8 inch thickness, clear acrylic with abrasion resistant coating.
 - e. Passage Opening: 36 inches width.
 - f. Operation: Controlled passage.
 - g. Communication System: Illuminated visual status display.
 - h. Systems Integration: Coordinate with facility access control and fire systems.

2.2 STANCHIONS

- A. Stanchions: Retractable.
 - 1. Manufacturer and Product: Q-Cord Retractable 39 inches Barriers, as basis of design.
 - a. Base Type: Freestanding.
 - 1) Finish: Stainless steel.
 - b. Cord Color: Grey.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Confirm finish flooring installation is complete and dry.
- B. Inspect floor is level at footprint of installation within 1/8 inch tolerances.
- C. Confirm power supply is installed per manufacturer written instructions.

- D. Inspect acrylic panels with abrasive resistant coating for damages.

3.2 INSTALLATION

- A. Erect turnstile per manufacturer written instructions.
- B. Set units level, plumb, and with uniform, hairline joints. Anchor securely into place.

3.3 ADJUSTING

- A. Adjust turnstile, hardware, and sensors for smooth operation and proper performance.
- B. Adjust stanchion retractable cords for smooth operation.

3.4 CLEANING

- A. Clean metal, solid surface, and acrylic panels per manufacturer written instructions.

3.5 DEMONSTRATION

- A. Engage a factory-trained installer to train Owner maintenance personnel on proper Optical Turnstile operation and necessary service requirements such as lubrication, cleaning, and inspection of components.

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SECTION 11 24 23
MAINTENANCE SAFETY EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes rooftop fixed equipment for the safe maintenance of the roof exterior of the building including but not limited to:
 - 1. Safety Tie-backs.
 - 2. Coping Protective System
 - 3. Thermal Isolation Plates to mount tie-backs.
- B. Related Requirements:
 - 1. Division 01 Section – “Sustainability Design Requirements”
 - 2. Section 01 43 25 “Exterior Enclosure Performance Mockup”.
 - 3. Section 01 45 25 “Exterior Enclosure Testing Services”
 - 4. Section 01 83 16 “Exterior Enclosure General Requirements” for additional requirements related to the building enclosure including but not limited to:
 - a. Performance and design requirements for the exterior building enclosure.
 - b. Coordination of Work required to complete the Exterior Enclosure.
 - c. Quality Assurance and Control procedures required for the work of the Exterior Enclosure.
 - 5. Division 3 Section 03 30 00 "Cast-in-Place Concrete" for setting inserts and for anchoring devices in concrete.
 - 6. Division 5 Sections 05 12 00 "Structural Steel" for performance requirements of connections to building primary structural frame.
 - 7. Division 7 Sections for waterproofing, air barrier, roofing, flashing and other requirements for making the building watertight.
 - 8. Division 9 09 96 10 High Performance Coating Sections for field painting.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate connection of work of this section to adjacent components of the exterior enclosure. Participate in coordination required in Division 01 Section 01 43 25 “Exterior Enclosure Performance Requirements”.
 - 1. Coordinate with roofing and waterproofing work.
 - 2. Provide input for the Coordinated Roof plan specified in Division 7.

B. Preinstallation Meetings:

1. Preinstallation Conference: Participate in Conference indicated in Division 01 Section 01 43 25 "Exterior Enclosure Performance Requirements.
2. Exterior Enclosure Coordination Workshop: Participate in workshop indicated in Division 01 Section 01 43 25 "Exterior Enclosure Performance Requirements."
3. Participate in Pre-roofing and Pre-waterproofing conferences specified in Division 7

C. Sequencing / Scheduling: Comply with requirements specified in Division 1 Section 01 43 25 "Exterior Enclosure Performance Requirements".

1.3 PERFORMANCE REQUIREMENTS

A. General Performance: Comply with performance requirements specified without failure due to defective materials, manufacture, fabrication, installation, or other defects in construction.

B. Scope: Design a complete system capable of providing access to the entire façade of the building, whether all components of that system are specifically indicated in this section or not.

C. Delegated Design: Design Maintenance Safety Equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1. Design additional reinforcing of structural members if loads imposed by anchors exceed allowable loads for the specific member as determined by Architect.

D. Code and Reference Standard Requirements

1. Safety anchor system design shall comply with current OSHA, ANSI, and local regulations pertaining to façade access, window cleaning and fall protection.
2. Anchor system shall provide independent fall arrest anchorages in addition to suspension line anchorages for each descent location as required by OSHA and ANSI requirements.
3. System shall be designed to be compatible with current window cleaning industry standard equipment (examples: rope descent systems, boatswain chairs, swing stages, transportable suspension devices).
4. Occupational Safety and Health Standards include but are not limited to the following:
 - a. ANSI/IWCA I-14.1-2001 Window Cleaning Safety
 - b. 1910 Subpart D (Walking and Working Surfaces)
 - c. 1910.66 Appendix C (Personal Fall Arrest)
 - d. 1910.66 Subpart F (Powered Platforms)
 - e. OSHA procedures and precautions for employees using descent control

E. Structural design requirements of anchorages, bases and tie-back

1. Comply with AISC publications:
 - a. Load and Resistance Factor Design for Structural Steel Buildings
 - b. Specifications for the Design of Cold-Formed Steel Structural Members
2. Design safety anchors and equipment supports to AISC S342L (including supplement No.1) and ANSI/IWCA I-14.1, and as follows:
 - a. Comply with OSHA 1910, Subpart F, Appendix C.
3. Safety Tie-Backs
 - a. Anchorage shall be capable of sustaining a minimum ultimate load of 5,000 lbs., in any direction the load may be applied, without fracture or failure.
 - b. Anchorage shall be capable of sustaining a minimum proof load of 2,500 lbs., in any direction the load may be applied, without permanent deformation or damage to anchorage.
 - c. Anchorages shall be designed with a minimum 1,250 lb. working load, in any direction the load may be applied.
4. Parapet, coping or guardrails subject to direct loading by workers' ropes or cables, shall be designed with accessories protective devices to withstand such loading without damage to either the structure or the rigging component in contact with it.

F. Location and Layout: At a minimum provide Maintenance Safety Equipment at locations indicated plus additional locations required to comply with indicated performance criteria.

1. Locate safety tiebacks in conjunction with areas on façade of building needing to be serviced. Consideration shall be given to the type of suspension equipment that will be used at the building and conditions such as workers' reach, rigging methods, and roof edge conditions. Anchorages shall be unobstructed and located behind and in line with equipment or portion of building they are intended to service.
2. Align anchors with building structural members capable of supporting load where possible. Provide additional reinforcing of structural members if loads imposed by anchors exceed allowable loads for the specific member as determined by Architect.

1.4 ACTION SUBMITTALS

- A. Product Data: Include capacities, sizes, performances, operations, safety features, controls, and finishes for exterior building maintenance equipment.

- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Load Requirements: Show loads imposed on the building structure.
 - 2. Prepare calculations in accordance with OSHA 1910.66 requirements.
 - 3. Shop Drawings shall be signed and sealed by the Delegated Design Engineer.

1.5 DELEGATED-DESIGN SUBMITTALS

- A. Delegated-Design Submittal: Engineering analytical data and calculations, sufficient to demonstrate compliance with design and performance requirements indicated, signed and sealed by the qualified professional engineer licensed in State of Delaware responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of maintenance safety equipment, signed by product manufacturer.
- B. Qualification Data: For qualified Manufacturer, Installer and Delegated Design professional engineer.
 - 1. Delegated Design Engineer Certificate of Insurance
- C. Manufacturer Certificates: Signed by manufacturer certifying that Maintenance Safety Equipment complies with the following.
 - 1. Compliance with performance requirements.
 - 2. Certify that materials are appropriate for indicated use and substrates and adjacent materials are compatible.
 - 3. Certify Manufacturer qualifications.
 - 4. Certify Manufacturer's approval of Installer qualifications.
 - 5. Certify Delegated Design Engineers qualifications.
 - 6. Certify single source responsibility.
 - 7. Certify acceptability to manufacturer of products specified in or required by this Section that are not produced by the manufacturer who submits this Certification.
 - 8. Certify that system/assembly depicted in Shop Drawings and other submittals, when installed as detailed, will result in performance substantially the same as it did in the tests on which the manufacturer bases their predictions of structural capacity and other salient performance criteria in compliance with the Contract Documents. Include the primary products, all accessories, interface and anchorage to adjacent construction and all other work of this Section included in the submittals.
 - 9. Manufacturer's completed Certificate of Insurance.
- D. Welding certificates.

- E. Field quality-control reports.
- F. Inspection Log: For documenting the required inspections.
- G. Operating Procedures: Submit an Operating Procedure including necessary elements in both pictorial and written form, to instruct employees in safe use of roof supported building maintenance equipment and window washing procedures.
 - 1. Isometric or plan view pictorial drawing of buildings roof, including building's name, address, and date OPOS was prepared. Ensure drawing is legible and kept with building's written assurance.
 - 2. Identification of drop zones, recommended drop sequences, scaffold configurations, as specific building maintenance procedures including equipment to be used.
 - 3. Identification of anchorage points for personal fall arrest systems and building maintenance equipment.
 - 4. Identification of personal fall protection requirements and procedures for securing equipment.
 - 5. Identification of dangerous areas on roof by highlighting of "Danger Zone" on pictorial drawing.
 - 6. Description of means and methods to be used to transfer equipment from drop location of between building levels.
 - 7. Identification of equipment limitations, load ratings, and special use conditions.
 - 8. Provisions for pre-operational, operation and maintenance inspections.
 - 9. Identification of access and egress to work locations and storage area(s) for permanent or transportable building maintenance equipment.
 - 10. Indication of location and method of stabilization provided for suspended equipment.
 - 11. Emergency and rescue procedures and means of communications to be used during such procedures.
 - 12. Method to be used to control employee exposure to falls when in "Danger Zone."

1.7 CLOSEOUT SUBMITTALS

- A. "Record Submittals" – Include record shop drawings of the system and final record copy of all submittals.
- B. Delegated Design Engineer's Field Quality Control report.
- C. Operation and Maintenance Data: For exterior building maintenance equipment to include in emergency, operation, and maintenance manuals.
 - 1. Manufacturer's instructions covering maintenance requirements and parts catalog giving complete list of repair and replacement parts with cuts and identifying numbers.
 - 2. Two copies of system Equipment Manual and Inspection Log Book, with "Initial Inspection – Certification for Use" and "Inspection Sign-Off" forms completed.

3. Two copies of reduced "as-built shop drawings and submittals" showing equipment locations and details.
 4. Provide scanned electronic copies of all documents on a thumbdrive.
- D. Warranty: Special warranty specified in this Section.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer capable of fabricating Maintenance Safety Equipment that meet or exceed performance requirements indicated and of documenting this performance by certification, labeling, and inclusion in lists.
1. Experience: Minimum five (5) years producing products similar to those required for this Project. Provided products for three (3) projects of scope, schedule and complexity similar to this Project within last two (2) years as acceptable to Architect.
 2. Miscellaneous metal fabrication of items other than Maintenance Safety Equipment shall not be considered as relevant to qualifications.
 3. Insurance: Manufacturer shall carry liability insurance to protect against product and system failure in amount of \$5,000,000 minimum. State of Delaware OMB/DFM, Tevebaugh Architecture, and RWDI USA LLC shall be named as "Additional Insured". Submit Certificate of Insurance.
 4. Certify compliance. Include project descriptions with Owner and Design Professional contacts for previous experience and resume for key personnel.
- B. Delegated Design Engineer: Professional Engineer, licensed in State of Delaware and having a minimum of five (5) years documented experience designing maintenance safety equipment and fall safety systems similar to those required for this Project.
1. Delegated Design Engineer shall sign and seal calculations and shop drawings.
 2. Delegated Design Engineer shall provide Field Quality Control services indicated.
 3. Delegated Design Engineer shall provide Warranty Inspection indicated.
 4. Certify compliance. Include project descriptions with Owner and Design Professional contacts for previous experience and resume for designer.
 5. Insurance: Delegated Design Engineer shall carry professional liability insurance to protect against negligent design in amount of \$5,000,000 minimum. State of Delaware OMB/DFM, Tevebaugh Architecture, and RWDI USA LLC shall be named as "Additional Insured". Submit Certificate of Insurance.
- C. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
1. Experience: Minimum five (5) years installing products similar to those required for this Project.
 2. Completed three (3) projects of scope, schedule and complexity similar to this Project using systems similar to those required for this Project within last two (2) years as acceptable to Architect.

3. Adequately trained by manufacturer and recommended in writing by manufacturer for type of fabrication and installation required for this Project.
4. Certify compliance. Include project descriptions with Owner and Design Professional contacts for previous experience.

D. 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."

E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section 01 31 00 "Project Management and Coordination."

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle materials, components, and equipment in manufacturer's protective packaging.
- B. Store materials, components, and equipment off of ground, under cover, and in a dry location. Handle according to manufacturer's written recommendations to prevent damage, deterioration, or soiling.

1.10 WARRANTY

- A. Special Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to repair, restore, or replace defective FMAE work within specified warranty period.
 1. Warranty Period: Two year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following:
 1. American Anchor
 2. Guardian Fall Protection
 3. Pro-Bel Enterprises Ltd.
 4. Tractel Limited
 5. Winsafe Corporation

2.2 MATERIALS

- A. Recycled Content of Steel Products: Provide steel plates, shapes, bar and framing with minimum 30 percent total recycled content, including at least 25 percent post-consumer recycled content.
- B. Recycled Content of Aluminum Products: Provide aluminum with minimum 30 percent total recycled content, including at least 25 percent post-consumer recycled content.
- C. Ferrous Metal:
 - 1. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
 - 2. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304.
 - 3. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.
- D. Nonferrous Metal:
 - 1. Aluminum Plate and Sheet: ASTM B 209 (ASTM B 209M), Alloy 6061-T6.
 - 2. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T6.
 - 3. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T6.
 - 4. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.

2.3 MISCELLANEOUS MATERIALS

- A. Thermal Isolation Plate: Load bearing thermal break plate used between flanged steel connections with high compressive strength combined with low thermal conductivity.
 - 1. ½" thick by full size of base plates.
 - 2. Fabreeka TIM or approved equivalent.
- B. Cast-in-Place Anchors in Concrete: Anchors capable of sustaining, without failure, a load equal to four times the load imposed, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
 - 1. Threaded or wedge type; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, hot-dip galvanized per ASTM A 153/A 153M.
- C. Fasteners and Accessories: Corrosion-resistant, nonstaining, nonbleeding self-locking fasteners.
 - 1. Materials: Stainless steel, ASTM F 593 and F 594, Alloy Group 1.
- D. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- E. Shop Primers: Provide primers that comply with Division 9 Section 09 96 10"High-Performance Coatings."

- F. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.
- G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
- H. Galvanize miscellaneous framing and supports where indicated.

2.4 COMPONENTS

A. Safety Tieback Anchors

1. Roof Mount: tieback anchors, minimum height of 12" above roof membrane. Anchors shall have a 2 1/2" inside diameter stainless steel ring for means of attaching a suspension wire rope or safety lifeline. Provide base plate for attachment to structural steel framing. Provide a thermal isolation plate below each base plate.
2. Anchors shall be hot-dipped galvanized except where indicated to be stainless steel. Any vent/drain holes for dipping shall be located in baseplate so exposed portion of anchor is watertight.
3. Wall Anchor Mount: Anchor shall be designed for bolting or welding to structural steel members.
4. Where safety tieback anchors are required to be installed at locations without sufficient structure to accommodate load, provide additional reinforcing members to building structure, enlarged plates or similar provisions to properly distribute load to structure.
5. Hardware, clips, bolts, nuts, washers, etc. shall be stainless steel.

B. Coping Protection: Device designed to distribute loads from any ropes extending over the copings, parapets or roof edges. Device shall also protect copings from damage and marring of finishes. Provide 4 coping protection devices.

1. Fabricate from heavy duty aluminum plate material.
2. Provide welded loops for handling.
3. Profile shall be suitable to fit over the parapets and copings used on this project.
4. Pad bottom of device with heavy duty carpet material adhered over foam.

2.5 FINISHES, GENERAL

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

2.6 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanizes items as indicated to comply with applicable standard listed below:
1. ASTM A 123/A 123M, for galvanizing steel and iron products.
 2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.

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 work.
1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General:
1. Comply with manufacturer's written instructions.
 2. Comply with approved shop drawings.
 3. Rigidly secure nonmovement joints.
 4. Install anchors with thermal shims, separators and isolators to prevent heat transfer, metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
- B. Metal Protection:
1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape or installing nonconductive spacers as recommended by manufacturer.
 2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- C. Install equipment by qualified installers who are familiar with all aspects of the work involved.
- D. Install work under the direct supervision of the equipment manufacturer.

3.3 ADJUSTING AND CLEANING

- A. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 9 painting Sections.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.4 FIELD QUALITY CONTROL

- A. Independent Inspection: The Delegated Design engineer who performed analysis for Maintenance Safety Equipment and signed and sealed submittals shall provide independent inspection either directly or by delegation to a local qualified engineer under the direct control and authority of the delegated design engineer who shall remain responsible.
 - 1. Inspections and site visits shall be performed while installation of equipment is in progress.
 - 2. On site inspection of equipment welded to structure shall be performed by an AWS Certified Welding Inspector verifying, in writing, size and quality of welds. Such an inspection shall be performed on each piece of equipment before roofing material is installed.
 - 3. On site inspection shall be performed on all cast in place items while being tied in with the rebar with sufficient time before concrete is poured to allow to adjustments to embedded items as recommended by inspector.
 - 4. Inspector shall be present during all testing.
 - 5. Schedule above site visits and inspections with sufficient advanced notice given to the inspection company.
 - 6. Prepare inspection reports documenting all findings:
 - a. Maintain a deficiency log and back-check that each deficiency identified has been properly resolved and record in log.
 - b. Report on all testing completed, successful and unsuccessful.
 - c. Report on all work done to correct deficiencies and failed tests.
- B. Testing:
 - 1. Engage a qualified testing agency to perform tests and inspections.
 - 2. Perform all testing as required by local authorities. These tests shall be separate from any owner training or demonstrations. Provide fees, permits and inspections.
 - 3. After all testing is completed provide a written certificate of compliance that all systems have been successfully operated following the procedures specified to the owner.
 - 4. Site Tests
 - a. All equipment shall be tested on site in accordance with manufacturer's recommendations, under the supervision of the delegated design

- professional engineer, and ANSI/IWCA I-14.1-2001 Window Cleaning Safety Standards, before being placed in service.
- b. Testing: Test on site 100% of Maintenance Safety Equipment using load cell test apparatus in accordance with manufacturer's written recommendations.
- c. Equipment shall be tested under the supervision of the Delegated Design Engineer.

5. Prepare test reports documenting all findings.

- a. Document all test failures and corrections until successful testing.

3.5 ADJUSTING AND CLEANING

- A. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 9 painting Sections.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.6 TRAINING

- A. Instruct the Owner's Representatives and selected User Personnel in the proper usage of the Maintenance Safety Equipment.
- B. A representative of the Maintenance Safety Equipment manufacturer shall, at time as selected by the Owner, spend one full eight hour day at the building providing instruction.
- C. Issue Maintenance Safety Equipment training attendance certificates to each Owner's Representative and selected User Personnel upon successful completion of training.

3.7 WARRANTY INSPECTION

- A. Maintenance Safety Equipment Installer and Delegated Design Engineer shall inspect and re-test the installed equipment approximately 10 months after Substantial Completion but within one year.
 - 1. Provide the Owner with a written report documenting any deficiencies noted or recommendations for equipment improvement.
 - 2. Any deficiencies noted shall be immediately corrected at no cost to the owner.

END OF SECTION

SECTION 12 24 13

ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manually operated roller shades with single rollers.
2. Motor-operated roller shades with single rollers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.

B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.

1. Motor-Operated Shades: Include details of installation and diagrams for power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified, 10 inches (250 mm) long.

D. Samples for Initial Selection: For each type and color of shadeband material.

1. Include Samples of accessories involving color selection.

E. Samples for Verification: For each type of roller shade.

1. Shadeband Material: Not less than 10 inches (250 mm) square. Mark interior face of material if applicable.
2. Roller Shade: Full-size operating unit, not less than 16 inches (400 mm) wide by 36 inches (900 mm) long for each type of roller shade indicated.
3. Installation Accessories: Full-size unit, not less than 10 inches (250 mm) long.

F. Product Schedule: For roller shades. Use same designations indicated on Drawings.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of shadeband material.

- C. Product Test Reports: For each type of shadeband material, for tests performed by a qualified testing agency.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For roller shades to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Roller Shades: Two full-size units for each type, color, and shadeband material indicated.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 - 1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain roller shades from single source from single manufacturer.

2.2 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS

- A. Manufacturer and Product: MechoShade Systems, LLC., Mecho/5, as basis of design.
- B. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.
1. Bead Chains: Manufacturer standard.
 - a. Loop Length: Full length of roller shade.
 - b. Limit Stops: Provide upper and lower ball stops.
 - c. Chain-Retainer Type: Clip, jamb mount.
 2. Spring Lift-Assist Mechanisms: Manufacturer standard for balancing roller shade weight and for lifting heavy roller shades.
 - a. Provide for shadebands that weigh more than 10 lb (4.5 kg) or for shades as recommended by manufacturer, whichever criterion is more stringent.
- C. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
1. Roller Drive-End Location: See Drawings.
 2. Direction of Shadeband Roll: Regular, from back/exterior face of roller.
 3. Shadeband-to-Roller Attachment: Manufacturer standard method.
- D. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- E. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.
- F. Shadebands:
1. Shadeband Material: Light-filtering fabric and Light-blocking fabric.
 2. Shadeband Bottom/Hem Bar: Steel or extruded aluminum.
 - a. Type: Enclosed in sealed pocket of shadeband material.
 - b. Color and Finish: As selected by Architect from manufacturer full range.

G. Installation Accessories:

1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
 - a. Shape: L-shaped.
 - b. Height: Manufacturer standard height required to conceal roller and shadeband assembly when shade is fully open, but not less than 4 inches (102 mm).
2. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.
 - a. Height: Manufacturer standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than height indicated on Drawings.
3. Endcap Covers: To cover exposed endcaps.
4. Installation Accessories Color and Finish: As selected from manufacturer full range.

2.3 MOTOR-OPERATED, SINGLE-ROLLER SHADES

- A. Manufacturer and Product: MechoShade Systems, LLC., ElectroShade Motorized Shade Systems, as basis of design.
- B. Motorized Operating System: Provide factory-assembled, shade-operator system of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-rewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
 1. Electrical Components: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Electric Motor: Manufacturer standard tubular, enclosed in roller.
 - a. Electrical Characteristics: 110-V ac.
 - b. Maximum Total Shade Width: As required to operate roller shades indicated.
 - c. Maximum Shade Drop: As required to operate roller shades indicated.
 - d. Maximum Weight Capacity: As required to operate roller shades indicated.
 3. Remote Control: Electric controls with NEMA ICS 6, Type 1 enclosure for surface mounting. Provide the following for remote-control activation of shades:
 - a. Keyed Control Station: Keyed, maintained-contact, three-position, switch-operated control station with open, close, and off functions. Provide two keys per station.
 - b. Individual Switch Control Station: Maintained-contact, wall-switch-operated control station with open, close, and center off functions.
 - 1) Switch Positions: Three.
 - 2) Switch Style: Toggle.

- c. Group Control Station: Maintained-contact, three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for single-switch group control.
- 4. Crank-Operator Override: Crank and gearbox operate shades in event of power outage or motor failure.
- 5. Limit Switches: Adjustable switches interlocked with motor controls and set to stop shades automatically at fully raised and fully lowered positions.
- 6. Operating Features:
 - a. Group switching with integrated switch control; single faceplate for multiple switch cutouts.
 - b. Capable of interface with audiovisual control system.
 - c. Capable of accepting input from building automation control system.
 - d. Override switch.
- C. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
 - 1. Roller Drive-End Location: See Drawings.
 - 2. Direction of Shadeband Roll: Regular, from back, exterior face, of roller.
 - 3. Shadeband-to-Roller Attachment: Manufacturer standard method.
- D. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- E. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers that are operated by one roller drive-end assembly.
- F. Shadebands:
 - 1. Shadeband Material: Light-filtering fabric and Light-blocking fabric.
 - 2. Shadeband Bottom/Hem Bar: Steel or extruded aluminum.
 - a. Type: Enclosed in sealed pocket of shadeband material.
 - b. Color and Finish: As selected by Architect from manufacturer's full range.
- G. Installation Accessories:
 - 1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
 - a. Shape: L-shaped.
 - b. Height: Manufacturer standard height required to conceal roller and shadeband assembly when shade is fully open, but not less than 4 inches (102 mm).
 - 2. Endcap Covers: To cover exposed endcaps.
 - 3. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel.

- a. Height: Manufacturer standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than height indicated on Drawings.
 - b. Provide pocket with lip at lower edge to support acoustical ceiling panel.
4. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.
 - a. Closure-Panel Width: 3-inch.
5. Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops.
6. Bottom/Sill Channel or Angle: With light seals and designed to eliminate light gaps at bottoms of shades when shades are closed.
7. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.4 SHADEBAND MATERIALS

- A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- B. See Finish Legend on Drawings for shadeband material selections.

2.5 ROLLER SHADE FABRICATION

- A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.
- B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F (23 deg C):
 1. Between/Inside Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch (6 mm) per side or 1/2-inch (13-mm) total, plus or minus 1/8 inch (3.1 mm). Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch (6 mm), plus or minus 1/8 inch (3.1 mm).
 2. Outside of Jamb Installation: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.
- C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible, except as follows:
 1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.
 2. Skylight Shades: Provide battens and seams at uniform spacings along shadeband as required to ensure shadeband tracking and alignment through its full range of movement without distortion or sag of material.

3. Railroaded Materials: Railroad material where material roll width is less than the required width of shadeband and where indicated. Provide battens and seams as required by railroaded material to produce shadebands with full roll-width panels plus, if required, one partial roll-width panel located at top of shadeband.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, locations of connections to building electrical system, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ROLLER SHADE INSTALLATION

- A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer written instructions.
 1. Opaque Shadebands: Located so shadeband is not closer than 2 inches (51 mm) to interior face of glass. Allow clearances for window operation hardware.
- B. Electrical Connections: Connect motor-operated roller shades to building electrical system.
- C. Roller Shade Locations: See Drawings.

3.3 ADJUSTING

- A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

- A. Clean roller shade surfaces, after installation, according to manufacturer written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motor-operated roller shades.

END OF SECTION

NOT FOR BID

**SECTION 12 36 00
COUNTERTOPS**

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Solid-surface-material countertops.
2. Quartz agglomerate countertops.
3. Plastic Laminate countertops.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For countertop materials.
2. For each type of product, including panel products and finishing materials and processes.

B. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, field joints, and cutouts for plumbing fixtures.

C. Samples for Initial Selection: For each type of material exposed to view.

D. Samples for Verification: For the following products:

1. Countertop material, 6 inches square.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

B. Product Certificates: For each type of product.

C. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

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.

1.5 PROJECT 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 deg F and relative humidity between 25 and 55 percent during the remainder of the construction period.
- B. Field Measurements: Verify dimensions of countertops by field measurements after base cabinets are installed but before countertop fabrication is complete.

1.6 COORDINATION

- A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 SOLID-SURFACE-MATERIAL COUNTERTOPS

- A. Solid Surface Material: Homogeneous solid sheets of filled plastic resin complying with ANSI SS1.
- B. Configuration: Provide countertops as indicated on Drawings.
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Avonite Surfaces.
 - 2. E. I. du Pont de Nemours and Company.
 - 3. Formica Corporation.
 - 4. LG Chemical, Ltd.
 - 5. Meganite Inc.
 - 6. Samsung Chemical USA, Inc.
 - 7. Swan Corporation (The).
 - 8. Transolid, Inc.
 - 9. Wilsonart International.
- D. Countertops: 1/2-inch-thick, solid surface material with front edge built up with same material.
- E. Fabrication: Fabricate tops in one piece with shop-applied edges unless otherwise indicated. Comply with solid-surface-material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
 - 1. Install integral sink bowls in countertops in the shop.

2.2 QUARTZ AGGLOMERATE COUNTERTOPS

- A. Quartz Agglomerate: Solid sheets consisting of quartz aggregates bound together with a matrix of filled plastic resin and complying with the "Physical Characteristics of Materials" Article of ANSI SS1.

- B. Configuration: Provide countertops with the following front and backsplash style:
 - 1. Front: Straight, slightly eased at top.
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cambria.
 - 2. Cosentino USA.
 - 3. E. I. du Pont de Nemours and Company.
 - 4. LG Chemical, Ltd.
 - 5. Meganite Inc.
 - 6. Samsung Chemical USA, Inc.
 - 7. Technistone USA, Inc.
 - 8. Transolid, Inc.
- D. Countertops: 2mm-thick, quartz agglomerate with front edge built up with same material.
- E. Fabrication: Fabricate tops in one piece with shop-applied edges and backsplashes unless otherwise indicated. Comply with quartz agglomerate manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.

2.3 PLASTIC-LAMINATE COUNTERTOPS

- A. Architectural Woodwork Standards Grade: Custom-
- B. High-Pressure Decorative Laminate Grade: HGS.
- C. Colors, Patterns, and Finishes: As selected by Architect from manufacturer's full range.
- D. Edge Treatment: Same as laminate cladding on horizontal surfaces.
- E. Core Material: Exterior grade veneer core plywood.
 - 1. Core Thickness: 3/4 inch.
 - 2. Build up countertop thickness to 1-1/2 inches at front, back, and ends with additional layers of core material laminated to top.

2.4 ACCESSORY MATERIALS

- A. Provide adhesives as recommended by finish material manufacturer for each application.

2.5 FABRICATION

- A. Fabricate countertops to dimensions, profiles, and details indicated. Provide front and end overhang of 1 inch over base cabinets. Ease edges to radius indicated.
- B. 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.

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.
- D. Install countertops level to a tolerance of 1/8 inch in 8 feet.
- E. Scribe and cut countertops to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- F. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Pre-drill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with

manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

1. Seal edges of cutouts in particleboard subtops by saturating with varnish.

3.3 CLEANING AND PROTECTION

- A. Repair or remove and replace defective work as directed on completion of installation.
- B. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.

END OF SECTION

SECTION 12 48 13

ENTRANCE FLOOR MATS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aluminum tile entrance mats.

1.2 COORDINATION

- A.** Coordinate size and location of recesses in concrete to receive floor mats and frames.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for floor mats and frames.

B. Shop Drawings:

1. Items penetrating floor mats and frames, including door control devices.
2. Divisions between mat sections.
3. Perimeter floor moldings.

C. Samples: For the following products, in manufacturer standard sizes:

1. Floor Mat: Assembled sections of floor mat.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data:** For floor mats and frames to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A.** Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Resilient-Tile Entrance Mats: Full-size tile units equal to 2 percent of amount installed, but no fewer than 10 units.

PART 2 - PRODUCTS

2.1 ENTRANCE FLOOR MATS AND FRAMES, GENERAL

- A. Structural Performance: Provide roll-up rail mats and frames capable of withstanding the following loads and stresses within limits and under conditions indicated:
 - 1. Uniform floor load of 300 lbf/sq. ft. (14.36 kN/sq. m).
 - 2. Wheel load of 350 lb (159 kg) per wheel.
- B. Accessibility Standard: Comply with applicable provisions in the DOJ "2010 ADA Standards for Accessible Design" and ICC A117.1.

2.2 ALUMINUM TILE ENTRANCE MATS

- A. Manufacturer and Product: Activar Construction Products Group Inc. Activ-Mat 800 Series, as basis of design.
 - 1. Depth: 3/8 inch.
 - 2. Tread Option: Architect selected.
- B. Installation Type: Recessed, no frame required.
- C. Description: Mechanically fabricated tiles from solid 5052-H32 aluminum plate with a minimum thickness of 0.25 inch. Machining is slotted providing free area for fall through of dirt and debris. Machining will also allow for recessed installation of chosen inserts.
 - 1. Aluminum Finish: Clear anodized.
- D. Aluminum Tile Inserts: Provide carpet or rubber inserts as selected by Architect from manufacturer full range.

2.3 CONCRETE FILL AND GROUT MATERIALS

- A. Provide concrete fill and grout equivalent in strength to cast-in-place concrete slabs for recessed mats and frames. Use aggregate no larger than one-third fill thickness.

2.4 FABRICATION

- A. Floor Mats: Shop fabricate units to greatest extent possible in sizes indicated. Unless otherwise indicated, provide single unit for each mat installation; do not exceed manufacturer recommended maximum sizes for units that are removed for maintenance and cleaning. Where joints in mats are necessary, space symmetrically and away from normal traffic lanes. Miter corner joints in framing elements with hairline joints or provide prefabricated corner units without joints.
- B. Finish Trims: As required provide custom perimeter trims for outer perimeter of walk off assembly.

- C. Coat concealed surfaces of aluminum frames that contact cementitious material with manufacturer standard protective coating.

2.5 ALUMINUM FINISHES

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

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and floor conditions for compliance with requirements for location, sizes, minimum recess depth, and other conditions affecting installation of floor mats and frames.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install recessed mats to comply with manufacturer written instructions so that tops of mats will be flush with adjoining finished flooring. Set mats with tops at height recommended by manufacturer for most effective cleaning action; coordinate tops of mat surfaces with bottoms of doors that swing across mats to provide clearance between door and mat.
 - 1. For installation in terrazzo flooring areas, allow for grinding and polishing of terrazzo without grinding surface of recessed frames. Coordinate with other trades as required.
 - 2. Install necessary shims, spacers, and anchorages for proper location, and secure attachment of frames.
 - 3. Delay setting mats until construction traffic has ended.

3.3 PROTECTION

- A. After completing frame installation and concrete work, provide temporary filler of plywood or fiberboard in recesses and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and Project is near Substantial Completion.

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SECTION 21 00 10

FIRE PROTECTION GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provision of the Contract, including General and Supplementary Conditions and Division 01 specifications, apply to the work specified in this Section.

1.2 SUMMARY

- A. This section describes the general provisions for the fire protection work included in Division 21. This section applies to all sections of Division 21.

1.3 RESPONSIBILITY

- A. The General Contractor shall be responsible for all work included in the Fire Protection Division and the delegation of work to Subcontractors shall not relieve him of this responsibility. Subcontractors who perform work under these Sections shall be responsible to the General Contractor. The term "Contractor" is used throughout this Division and shall mean the General Contractor, although the actual performance of the work may be by a Subcontractor.
- B. Delegated Design – Contractor is responsible to provide a complete design, including drawings and calculations prepared by a Licensed Professional Engineer or technician holding a NICET Level IV Certification for the fire protection system.

1.4 REFERENCES AND DEFINITIONS

- A. Following are definitions of terms and expressions used in the Fire Protection Sections in addition to those included in Division 01 Sections:
 - 1. Owner: State of Delaware, OMB / DFM
 - 2. Architects: Tevebaugh Architecture
 - 3. Engineers: Leach Wallace Associates, Inc.
 - 4. Concealed - "hidden from normal sight"; includes items in shafts, pipe and duct spaces, and above ceilings.
 - 5. Exposed - "not concealed" - Work within Equipment Rooms and all visible (normal sight) work shall be considered exposed".
 - 6. Piping - includes pipes, fittings, valves, hangers and accessories comprising a system.
 - 7. Directed- "directed by the Architect"
 - 8. Indicated- "indicated in Contract Documents"

1.5 STANDARD SPECIFICATION:

- A. References to catalogs, standards, codes, specifications, and regulations are the latest edition in effect at date of invitation to bid.

1.6 CODES, REGULATIONS AND PERMITS

- A. Give all necessary notices and obtain all required permits. Pay all fees and other costs, including utility connections or extensions in connection with the work. File all necessary plans, prepare all documents and obtain all necessary approvals of all governmental departments having jurisdiction. Obtain all required certificates of inspection and deliver same to the Architect before request for acceptance and final payment for the work.
- B. All materials furnished and all work installed shall comply with the latest rules, regulations, and recommendations of the following bodies:

ICC International Building Code (IBC)

ICC International Mechanical Code (IMC)

ICC International Plumbing Code (IPC)

Delaware State Fire Prevention Code

NFPA 13, Sprinkler Systems

NFPA 14, Standpipe and Hose Systems

NFPA 70, The National Electrical Code

1.7 Materials List and Shop Drawings

- A. See General Requirements.
- B. Refer to section 01 33 00 "Submittal Procedures" for submittal requirements and procedures.
- C. After receiving approval of equipment manufacturers and prior to delivery of any material to job site and sufficiently in advance of requirements to allow the Architect ample time for checking, submit for approval dimensioned drawings or cuts showing construction size, arrangement, operating clearances, performance characteristics and capacity of materials and equipment. Each item of equipment proposed shall be a standard catalog product of the approved manufacturer.
- D. Samples, drawings, specifications, catalogs, etc., submitted for approval shall be properly labeled indicating specific service for which material or equipment is to be used, section and article number of specifications governing, and Contractor's name, name of job, and date.
- E. Catalogs, pamphlets or other documents submitted to describe items on which approval is being required shall be specific and identification on catalog pamphlet, etc., of the item submitted shall be clearly made in ink. Data of a general nature will not be

accepted. Any deviations or exceptions taken in the specification by the Contractor shall be noted.

- F. Any deviations or exceptions taken in the specification by the Contractor shall be so noted.
- G. If material or equipment is installed prior to receipt by the Contractor approved shop drawings, marked "Approved", "No Exception Taken", or "Make Corrections Noted", the Contractor shall be liable for its removal and replacement at no extra charge to the Owner.
- H. The acceptance of shop drawings shall not relieve the Contractor from his responsibility to furnish material, equipment and systems and to perform work required by the contract documents. Neither the Owner nor the Architect will be responsible for errors or omissions on shop drawings furnished by the Contractor even though such shop drawings containing errors or omissions are inadvertently accepted.
- I. The Contractor is further advised that the Architect will not act as coordinator between suppliers and subcontractors. All required coordination shall be the responsibility of the Contractor.
- J. Calculations and shop drawings shall be submitted to the Architect and Owner's insurance carrier prior to being submitted to city and state agencies.

1.8 CONTRACTOR'S USE OF CAD/REVIT FILES

- A. At the Contractor's written request, copies of the Engineer's CAD / Revit files may be made available for Contractor use in connection with the project, subject to following conditions:
 - 1. Submit written request to the Architect listing the specific drawings the Contractor intends to use. Provide a specific list of submittals that the files will be used in preparing, and the list of names of subcontractors or suppliers.
 - 2. The Contractor shall request in writing the electronic transfer agreement. Prior to transfer of files, the Contractor shall prepare a separate electronic transfer agreement for each subcontractor or supplier who will be using the electronic files.
 - 3. Data contained on the electronic files is part of Leach Wallace Associates (LWA) instruments of service and shall not be used for any purpose other than as a convenience in the preparation of shop drawings for the referenced project. Any other use or reuse will be at the Contractor's sole risk and without liability or legal exposure to LWA.
 - 4. The electronic files are not contract documents. Significant differences may exist between the electronic files and the corresponding hard copy contract documents. Because of the possibility the information and data delivered in machine readable form may be altered, whether inadvertently or otherwise, LWA reserves the right to retain hard copy originals of the electronic documentation delivered to the contractor, in machine readable form, which the original shall be referred to and shall govern in the event of any inconsistency between the two.
 - 5. The use of the electronic files, does not relieve the Contractor of their duty to fully comply with the contract documents, including and without limitation, the need to

check confirm and coordinate all dimensions and details, take field measurements, verify field conditions and coordinate work with that of other Contractors for the project.

6. All "internal" calculations integral to / performed by the Revit model shall not be utilized for any purpose by the Contractor. This includes, but shall not be limited to, voltage drop calculations, duct static pressure calculations, air system airflow summary calculations, piping system pressure drop calculations, etc.
7. All Revit "families" are the property of LWA and shall not be re-used on any other project for any purpose by the Contractor.

1.9 GUARANTEE

- A. The Contractor guarantees by his acceptance of the Contract that all work provided shall be free from defects in workmanship and materials for a period of two years after date of substantial completion. Any defects in workmanship, materials or performance which appear within the guarantee period shall be corrected by the Contractor without cost to the Owner within a reasonable time to be specified in notice from the Architect. In default thereof, Owner may have such work done and charge the cost of same to the Contractor.

1.10 SITE VISIT

- A. Prior to preparing the bid, the fire protection subcontractors shall visit the site and familiarize themselves with all existing conditions. Make all necessary investigations as to locations of existing equipment, ductwork, piping, utilities, etc., work to be removed, and all other matters which can affect the work under the Contract. No additional compensation will be made to the contractor as result of his failure to familiarize himself with the existing conditions under which the work must be performed.
- B. Refer to Section 00 21 13 Instructions to Bidders, and Section 00 22 13 Supplementary Instructions to Bidders.

1.11 DRAWINGS

- A. The contract drawings are diagrammatic and indicate the general arrangements of systems and work included in the Contract. Do not scale the drawings. Consult the architectural and structural drawings and details for exact location of structure and equipment; where same are not definitely located, obtain this information from the Architect.

1.12 RECORD DRAWINGS

- A. The Contractor shall keep accurate records of all deviations in work are actually installed from work indicated. One complete set of contract documents shall be available at the construction site for indicating said deviations.
- B. When work is complete, make one (1) complete "AS Built" set of PDF files, certifying the accuracy of each drawing by endorsement and signature thereon and deliver to the Architect who will, after approval, deliver the record drawings to the owner.

- C. Refer to Section 01 78 39 Project Record Documents for specific requirements.

1.13 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. Contractor shall furnish to the Architect two (2) complete bound sets of typewritten or blueprinted instructions and one (1) PDF set for operating and maintaining all systems and equipment included in this Contract. Each set of instructions shall be contained in a hard-back ring binder properly indexed and labeled. Also provide two complete bound sets and one PDF set of approved shop drawings for all items of equipment utilized on the project. All instructions shall be submitted in draft for approval prior to the final issue. Manufacturers' advertising literature or catalogs will not be acceptable for operating and maintenance instructions.
- B. Contractor shall prepare Operation and Maintenance Data and submit in accordance with the requirements of Section 01 78 23 Operation and Maintenance Data.
- C. Instructions shall include a general description of each system together with specific instructions describing routine and emergency procedures required of the building maintenance personnel for operating and maintaining each system. The instructions shall include the name or label, location, and function of all operating equipment and controls, and the location of the electrical service and breaker I.D. numbers. Operating modes and the procedures for indexing each mode shall be clearly described. Include lubrication charts and schedules of frequency of lubrication for all equipment designating each point of lubrication and type of lubricant to be used. A listing of names, addresses, and phone numbers of the service organizations for each item of equipment and a typewritten maintenance schedule for same shall be included.
- D. Upon completion of all work and of all tests, at a minimum the Contractor shall furnish the necessary skilled labor and helpers for operating the systems and equipment for a minimum period of two (2) days of eight hours each, or as otherwise specified. Instruct the Owner's representative fully in the operating, adjustment and maintenance of all equipment furnished. Instruction shall be divided into Two (2) sessions of four hours each, each at a time directed by the Owner. Refer to section 01 79 00 Demonstration and Training for specific requirements.
- E. The instructors shall be thoroughly familiar with all part of the installation on which he is to give instruction and shall be trained in operating theory as well as practical operation and maintenance work. Employ factory trained instructors wherever necessary as determined by the Architect.
- F. During the guarantee period, the Contractor shall service all major equipment items provided under this contract, including fire pumps and controllers which require outside service agencies. Service shall not include filter replacement, lubrication of motors and bearing or continuation of water and special system chemical treatment after formal acceptance of the systems by the Architect. Prior to the start of guarantee period, the Contractor shall provide the Architect with a schedule of required maintenance operations for each item of equipment. Submit schedule to the Architect for approval. Thereafter, monthly reports shall be submitted to the Owner for describing actual service provided. Forty-eight (48) hours advance notice shall be given to the Owner prior to work required under this Section.

1.14 ELECTRICAL WORK

- A. Under Division 21 Fire Protection, provide the following items of electrical work which shall conform with the applicable requirements of the Electrical Division:
 - 1. Control wiring.
 - 2. Interlock wiring for fire protection equipment.
- B. Under Division 26, 27 or 28, provide:
 - 1. Power wiring complete from source to motor or equipment junction box, including power wiring through motor starters.
 - 2. Motor control centers or motor starter panelboards.
 - 3. All miscellaneous individual motor starters, local wall mounted control devices, unless noted or specified otherwise.
 - 4. All fire alarm interface wiring.

1.15 EQUIPMENT STARTUP AND INITIAL OPERATION

- A. No equipment shall be operated for testing or trial use except after compliance with the equipment manufacturers' specifications and instructions of the lubrication, alignment direction of rotation, balance and other applicable considerations.
- B. Particular care shall be taken to see that all equipment is completely assembled and properly lubricated and all grease and oil cased and reservoirs have been filled to the correct level with the recommended lubricant.
- C. It is the Contractor's responsibility to place each item of equipment installed by him in operating condition, including all auxiliaries, piping, wiring, etc., and to start up each unit and check it for performance.

1.16 WORK SITE FIRE PROTECTION

- A. As minimum, one five-pound CO2 extinguisher shall be provided with each work crew at all times when working within the building.

1.17 SCHEDULE OF WORK:

- A. Refer to project schedule. Specific phasing requirements are to be incorporated into project schedule. Contractor shall coordinate all work included in this section.

1.18 SERVICE AGENCIES

- A. All fire protection equipment suppliers shall have an established authorized service agency located within the area. Within 30 days after award of the Contract, the Contractor shall submit to the Architect for approval a list of manufacturers' material and equipment names, including their respective service agency, he proposes to use. In the event any service agency in the list fails to comply with the specification requirement, such service agency will be rejected.

1.19 SINGULAR NUMBER

- A. Where any device or part of equipment is herein referred to in the singular number (such as "valve"), such reference applies to as many such devices as are required to complete the installation, shown, implied or otherwise, as indicated on the drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All materials shall be new, the best of their respective kinds, suitable for the conditions and duties imposed on them at the building and shall be of reputable manufacturers. The description, characteristics, and requirements of materials to be used shall be in accordance with qualifying conditions established in the sections following.
- B. Refer to Division 01 for General Requirements.
- C. All component parts of each item of equipment or device shall bear the manufacturers' name plate, giving name of manufacturer, description, size, type, serial or model number, electrical characteristics, etc., in order to facilitate the maintenance or replacement. The name plate of a subcontractor or distributor will not be acceptable. All equipment requiring electrical service shall be U.L. labeled, or if a U.L. label is not available from the manufacturer, the equipment shall be tested by an approved electrical testing company in accordance with NEC, and at no additional cost to the Owner. Submit data indicating compliance with standards prior to installation.
- D. In specifying materials, four general procedures are used. The four classifications are as follows:
1. GROUP 1: When the material or equipment is specified by name of other identifying information and one name brand only is used, it is considered that the use of that particular item is essential to the project, and the Contractor shall base his proposal on the uses of that item.
 2. GROUP 2: When a material or equipment is specified by brand name and other identifying information and two or more brand names are named, it is considered that any one of the brands so named will be performed as desired, and the Contractor shall base his proposal on one of the named brands.
 3. GROUP 3: When the material or equipment is specified with the phrase "... or equal..." after a brand name and other identifying information, it is intended that the brand name is used for the purpose of establishing a minimum acceptable standard of quality and performance and Contractor may base his bid proposal on any item which is in all respects equal to that specified and presents essentially the same appearance, size, operation and performance. The Contractor shall be responsible for coordination of the equal product.
 4. GROUP 4: When material is specified as complying with the requirements of published "Standard Specification" of trade associations, American Society for Testing and Material, government specifications, etc., the Contractor shall base his proposal on any item which can be shown to comply in all respects to the referred to "Standard Specification."
- E. All substitutions shall be submitted in accordance with Instructions to Bidders and Section 01 25 00 Substitution Procedures. It is distinctly understood: (1) that the Architect will use his own judgment in determining whether or not any materials,

equipment or methods offered in substitution are equal to those specified and will fit within the space available; (2) that the decision of the Architect on all such questions of equality is final; and (3) that all substitutions will be made at no increases in cost to the Owner.

- F. Upon receipt of written approval from the Architect, Contractor may proceed with substitution providing the Contractor assumes full responsibility for and makes, at his expense, any change or adjustment in construction or connection with any work that may be required by the substitution of such materials, equipment or methods. In the event of any adverse decisions by the Architect, no claim of any sort shall be made or allowed against the Owner.

2.2 PIPING SUPPORTS, GENERALLY

- A. Comply with NFPA 13 Requirements for installation of sprinkler piping.
- B. Piping shall be run parallel with the lines of the building unless otherwise shown or noted on drawings. The different service pipes, valves, and fittings shall be so installed that after the covering is applied there will not be less than 1/2 inch clear space between the finished covering of parallel adjacent pipes. Hangers on different service lines running parallel with each other and nearly together shall be in line with each other and parallel to the lines of the building. Exact location of electric outlets, piping, ducts, and conduits shall be coordinated among the trades so that there will be no interference between lighting fixtures, piping, ducts, and conduits. Where conflicts between the trades result, they shall be resolved by the Contractor to the Architect's satisfaction and at no expense to the Owner.
- C. In general hangers shall be spaced so as to prevent sag and permit proper drainage and shall not be spaced more than 10 feet apart unless otherwise indicated herein, in Section 21 00 50, or on the drawings. Hangers shall be placed within one foot of each horizontal elbow. Provide hangers and supports in accordance NFPA 13.
- D. Vertical runs of pipe and conduit not over 15 feet long shall be supported by hangers placed not over one foot from the elbows on the connecting horizontal runs. Vertical runs of pipe and conduit over 15 feet long but not over 60 feet long and not over 6 inches in size shall be supported on heavy steel clamps. Clamps shall be bolted tightly around the pipes and conduits and shall rest securely on the building structure without blocking.
- E. Hangers shall be of manufacturers hereinafter specified in Section 21 00 50. Unless otherwise specified, pipe and conduit hangers and hanger supports shall conform with the following Anvil International figures:
 - 1. Hangers generally shall be Fig. 69, 104, 212, 260 and 300.
 - 2. Hangers Figs. 295 and 212 shall be provided with turnbuckles and eye rods or rods with eye nuts.
 - 3. Turnbuckles shall be Fig. 230 and 114, shall have not less than 1-1/2 inch adjustment, and shall be provided with lockouts.
 - 4. Clamps shall be Fig. 261 or CT-121.
 - 5. Wherever the movement of pipe due to expansion exceeds 3/4 inch per foot of hanger rod length, hangers shall be Figs. 171, 174 and 181.

6. Roller supports shall be adjustable.
 7. Concrete inserts shall be Fig. 282 or 281.
- F. Hanger attachments shall be suitable for each type of hanger and shall be compatible with the building material to which it is secured. Under no circumstances shall pipe support be secured to any other mechanical, electrical or fire protection equipment. Support shall be suspended from building structure only. The type of attachments which shall be used for the various types of building construction encountered are as follows:
1. Steel beams - Fig. 226, or 66 attachments.
 2. Bar joists - Fig. 225, or 60.
 3. Brick or block walls - Fig. 194, 195, 199 or 202 fastened as follows: For light duty, self-drilling anchors in brick and toggle bolts in block; for heavy duty, through bolts with backing plates.
 4. Concrete (New) - Inserts, Fig. 281 or 282. Power driver fasteners may be used for light loading as hereinafter specified.
- G. Welded attachments for securing hangers to piping or to structural steel may be provided in lieu of other attachments specified if prior approval is obtained in the field from the Architect. Welded attachments shall be designed so that the fiber stress at any point in the weld or attachment will not exceed the fiber stress in the hanger rod. Generally, welding shall not be permitted in finished spaces.
- H. In no case shall wire or perforated strap be used for pipe support.
- I. Secure all hangers for piping to joist and beams. In no case shall supports be secured to underside of metal or wood deck unless otherwise directed in the field by the Architect. Contractor shall submit details of method of attachments for approval to the Architect.

2.3 SLEEVES AND PLATES

- A. Pipe sleeves through concrete and masonry construction shall be Schedule 40 galvanized steel pipes unless otherwise indicated on the drawings. Openings that cannot be sleeved before slab or wall is poured shall be core drilled. Pipe sleeves through drywall and similar construction shall be sized to pass both pipe and insulation.
- B. Sleeves in existing concrete or masonry walls shall be set and secured with mortar grout and fast drying bitumastic sealant. Caulk the annular space of pipe sleeves with an elastic caulk compound to make installation air and watertight.
- C. Escutcheon plates shall be provided for all exposed pipes and conduits passing through walls, floors, and ceilings in finished areas. Plates shall be chrome plated brass of the split ring type, of size to match the pipe or insulation where installed. Where plates are provided for pipes passing through sleeves which extend above the floor surface, provide deep recessed plates to conceal the pipe sleeves.
- D. Utilize U.L. approved resilient sealant for all penetration seals. Submit method of sealing for approval.

- E. Where watertight sleeves are indicated or required to suit the installation, provide Link Seal rubber seals, as manufactured by Thunderline Corporation, between pipes and sleeves.

2.4 MOTORS

- A. Provide motors of a size adequate to drive the equipment but in no case less than the size shown or specified. If a motor larger than that specified is required, the Contractor shall bear the expense of changes in foundations, support, wire and conduit connections, circuit protective devices, variable frequency drives, or other affected elements of the system. Each motor shall have sufficient capacity to start and operate the machine it drives without exceeding the motor nameplate rating at the speed specified or at the load which may be obtained by the drive actually provided. Motors shall be rated for continuous duty at 115 percent of rated capacity; base temperature rise on an ambient temperature of 40°C.
- B. Motors for use with variable frequency controllers shall be "Inverter Ready", suitable for variable speed / variable torque applications, designed to withstand a rise time of 0.10 microseconds and a peak voltage of 1600 per NEMA MG1 Section 31.4.0.4.2.
- C. Motors 1/2 hp and larger shall be 3 phase, Class B, general purpose, squirrel cage, open type, high efficiency, induction motors, unless otherwise specified. Motors smaller than 1/2 hp shall be single phase, open capacitor type in accordance with NEMA standards wound for 115 volts, 60 Hertz, alternating current. Motors 1/6 hp and under may be split phase type.
- D. Motor efficiencies shall comply with the United States Energy and Independence and Security Act (EISA) of 2007 and the latest revision of NEMA Standard MG1 Table 12-2.
- E. Unless otherwise indicated each motor (5 HP or larger) or motor driven equipment (5 HP or larger) shall have a composite power factor (PF) rating of a minimum of 90% when the motor is operating at the design duty defined on the drawings. Power factor correction devices shall be provided to meet the stated criteria.
- F. Devices (such as: capacitors) or equipment (such as: solid state power factor controllers) when required for power factor correction shall be provided with the motors or item or motor driven equipment. The device shall be mounted and wired to the motor by the project electrical contractor.
- G. For a motor or motor driven equipment requiring other than across-the-line starting PF correcting capacitors (or other equipment) shall be connected to motor terminals via a contactor (controller) with a 120 VAC coil. The 120 VAC coil shall be energized via an auxiliary contact on the contactor (controller) used to establish the "run" operating mode for the motor or motor driven equipment.
- H. All motors for use with variable frequency controllers shall include a maintenance free, circumferential, conductive micro fiber bearing protection ring to discharge shaft currents to ground. Bearing protection rings shall be Aegis, model SGR, or approved equal. Bearing protection shall be installed and tested in accordance with the manufacturer's recommendations.

- I. All motors shall have a warranty period of 5 years from date of substantial completion.

PART 3 - EXECUTION

3.1 WORKMANSHIP

- A. Each subcontractor shall furnish the services of an experienced superintendent who shall be constantly in charge of the installation of the work.
- B. The quality of workmanship required for each trade in the execution of its work shall be the finest and highest obtainable in that trade working with the materials specified. Workmanship shall be satisfactory to the Architect and his decision as to acceptable quality if final.
- C. Contractor shall provide and execute a Quality Control plan in accordance with section 01 40 00 Quality Requirements.

3.2 EQUIPMENT CONNECTIONS

- A. All equipment shall be installed and connected in accordance with the best engineering practice and in accordance with manufacturer's instructions and recommendations. Auxiliary piping, valves, and electric connections recommended by the manufacturer or required for proper operation shall be provided.

3.3 COMMISSIONING RESPONSIBILITIES

- A. The contractor, and all the sub-contractors and suppliers within Division 21, shall cooperate with the commissioning agency (CA), and other commissioning team members, to facilitate the successful completion of the commissioning process.
- B. The contractor shall assign a representative to the commissioning team, and submit the person's name to the commissioning agency, within one (1) month of the award of the contract. The representative shall have the authority to make decisions on behalf of the contractor as they relate to the organization and scheduling of fire protection system commissioning. The representative shall ensure communications between Division 21 contractors and suppliers and all other commissioning team members, and shall foster the necessary cooperative action. One specific responsibility shall be to attend commissioning meetings, and ensure action items arising from them are attended to as required to allow the commissioning process to proceed on schedule.
- C. The Contractor, and all sub-contractors and suppliers, shall cooperate with the Commissioning Agency in carrying out the fire protection commissioning process. In this context, the Contractor shall:
 - 1. Each contractor and sub-contractor in this division shall include in their quotes the cost of participating in the commissioning process as specified herein.
 - 2. Provide instruction and demonstrations for the Owner's designated operating staff, in conjunction with the commissioning agency and mechanical engineer, and with the participation of qualified technicians from major equipment suppliers and the controls contractor.

3. Included requirements for submittal data, O&M data, and training information in each purchase order or sub-contract written.
4. Ensure cooperation and participation of specialty sub-contractors.
5. Ensure participation of major equipment manufacturing in appropriate start-up, testing and training activities.
6. Attend commissioning meetings scheduled by the CA.
7. Notify the CA a minimum of two weeks in advance of scheduled equipment and system start-ups, so that the CA may witness system verifications, and equipment and system startups.
8. Provide sufficient personnel to assist the CA as required during system verification and functional performance testing.
9. Prior to startup, inspect, check and confirm the correct and complete installation of all equipment and systems for which system verification checklists are included in the commissioning plan. Document the results of all inspections and checks on the checklist and sign them. If deficient or incomplete work is discovered, ensure corrective action is taken and re-check until the results are satisfactory and the system is ready for safe startup.
10. Provide equipment and systems startup resources as specified and required. If during an attempted equipment or system startup, deficient or incomplete work is discovered that would preclude safe operation, the startup shall be aborted until corrective action has been taken. Ensure such action is taken and verified before re-scheduling a new startup. Those responsible for deficient or incomplete work will be responsible for the costs associated with rescheduling.
11. Carry out performance checks to ensure that all equipment and systems are fully functional and ready for the CA to witness formal functional performance tests (FPTs).
12. Operate equipment and systems for FPT's in accordance with the commissioning plan and as directed by the commissioning agency. If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered, the FPT's will be stopped by the CA. Those responsible for deficient or incomplete work will be responsible for costs associated with rescheduling. Ensure that all corrections necessary for full and complete system operation as specified are completed; then with the AT contractor and other applicable sub-contractors, carry out functional performance checks to confirm correct operation before applying to the CA to reschedule the FPT's for the system in question.
13. Prepare preliminary schedule for fire protection system orientation and inspections, O&M manual submission, training sessions, pipe system testing, flushing and cleaning, equipment startup, TAB, and task completion for use by the CA. Update schedule as appropriate throughout the construction period.
14. Attend initial O&M staff training session.
15. Conduct fire protection system orientation and inspection at the equipment placement completion stage.
16. Update drawing to as-built condition and review with the CA.
17. Prepare O&M manuals as specified herein.
18. Participate in the O&M staff training sessions with vendors and contractors.
19. Provide written notification to the general contractor or construction manager and CA that the following work has been completed in accordance with the contract documents and the equipment, systems and sub-systems are operating as required.

- a. Fire protection equipment including all fire pumps, controllers, packaged systems, etc.
 - b. Fire protection systems.
 - c. Fire stopping in the fire rated construction, caulking, gasketing and sealing of smoke barriers.
 - d. That the fire alarm control system is functioning to control fire protection equipment as specified.
20. Provide a complete set of as-built drawings and O&M manuals to the CA for review.
21. Integrate installation and programming scheduling with construction and commissioning schedules.
22. Inspect, check and confirm that the correct installation and operation of input and output field point and devices through documented and signed off point-to-point checkouts.
23. Provide thorough training to operating personnel on hardware operations and programming, and the application program for the system, in accordance with the O&M staff training program in the commissioning plan.
24. In conjunction with the contractor, demonstrate system performance to the CA including all modes of system operation (e.g., emergency) during the functional performance tests (FPTs). If improper functionality, incomplete work, or other deficiencies affect system performance are discovered, the FPT's will be stopped by the CA. Those responsible for deficient or incomplete work will be responsible for rescheduling costs.
25. Provide system technician to assist during system verification and functional performance testing.

3.4 WATERPROOFING

- A. Under no circumstances shall waterproofing be damaged or penetrated. Should conditions arise which indicate such necessity, notify the Architect.

3.5 CUTTING AND PATCHING

- A. Cutting and patching associated with the work in the existing structure shall be performed in a neat and workmanlike manner. Existing surfaces which are damaged by the Contractor shall be repaired or provided with new materials and methods similar to existing adjacent work, subject to approval of the Architect. Structural members shall not be cut or penetrated unless otherwise indicated on the drawings. Verify in the field with the Architect. Holes cut through concrete and/or masonry to accommodate new work shall be cut by reciprocating or rotary non-percussive methods. Existing masonry block walls shall be patched with new masonry or gypsum board attached and sealed to both block faces.

3.6 SURVEYS AND MEASUREMENTS

- A. Base all measurements (both horizontal and vertical) from established benchmarks. All work shall agree with these established lines and levels. Verify all measurements at site and check correctness of same as related to the work. Verify locations of existing utilities and inverts of same prior to the start of any systems shown connecting to utilities.

- B. Should the Contractor discover any discrepancy between actual measurements or conditions and those indicated which prevent following good practice or the intent of the drawings and specifications, he shall notify the Architect and shall not proceed with his work until he has received instruction from the Architect.

3.7 HANDLING AND STORAGE OF MATERIALS

- A. Proper and suitable tools, equipment and appliances for the safe and convenient handling and placing of all materials and equipment shall be used. During loading, unloading, and placing, care shall be taken in handling the equipment and materials so that no equipment or materials, including Owner furnished, are damaged.
- B. All equipment delivered to the job site shall be stored under roof or other approved covering, on pedestals above the ground. All enclosures for equipment shall be weatherproof. Any motors which are not totally enclosed, that are involved in the work, shall be stored in a heated area with a minimum temperature of 50 deg F. All valves shall be stored under roof on wood pedestals above ground. All insulation shall be stored under roof or in trailers, adequately protected from the weather. The Contractor shall follow all written instructions and recommendations of the manufacturer and all requirements of the Architect in oiling, protection and maintenance of equipment during storage. It shall be the Contractor's complete responsibility for the storage and care of the equipment and materials.
- C. If any materials and/or equipment are found to be in poor condition at the time of being installed, the Architect may, at his discretion, order the Contractor to furnish and install new equipment at no cost to the Owner.

3.8 COOPERATION WITH OTHER TRADES

- A. Exact location of sprinkler heads, drains, piping and valves shall be coordinated with all other trades so that there will be no interference between lighting fixtures, piping, ducts, and conduits. Where conflicts between the trades result, they shall be resolved by the Contractor to the Architect's satisfaction and at no expense to the Owner.
- B. Fire Protection trades shall give full cooperation to other trades and shall furnish in writing, with copies to the Architect, all information necessary to permit the work of all trades to be installed satisfactorily and with the least possible interference or delay.
- C. Prior to the installation of all fire protection equipment and materials coordinate installation with all other trades.

3.9 CLEANING AND PAINTING

- A. Thoroughly clean all exposed surfaces of equipment and material and leave in a neat, clean condition ready for painting. Restore and touch-up factory finishes which have been damaged during construction. Finished painting will be performed under another Division.
- B. Miscellaneous requirements include:

1. Provide complete new finish if, in the opinion of the Architect, the factory finishes are severely damaged.
2. Touch up threads of zinc coated screwed pipe with Rustoleum primer and one coat of enamel conforming to painting specification.
3. All exposed hangers, steel supports and miscellaneous components, and cast iron pipe hangers shall be field painted with Rustoleum primer and one coat of enamel conforming to painting specification.
4. All steel support and miscellaneous components shall be painted with Rustoleum primer and one coat of enamel conforming to the painting specification.

3.10 ACCESSIBILITY

- A. Locate all equipment which must be serviced, operated or maintained, in fully accessible positions including valves and drains. Where required and where directed, provide 14 gauge steel access panels, Milcor or equal, to suit material in which installed. Doors installed in fire rated walls or shafts shall be labeled and shall match rating of the construction. Door shall be of sufficient size to allow access to all components, except minimum size shall be 24" x 24", unless otherwise noted.
- B. Equipment deemed inaccessible by the Architect shall be reworked by the Contractor at no expense to the Owner. All doors shall have cylinder locks operable from same key. Submit shop drawings for approval.

3.11 EQUIPMENT BASES SUPPORTS

- A. Under this Division provide all equipment supports required for the fire protection work.
- B. Provide structural members and related materials, inertia pads, platforms, and gratings.
- C. All concrete bases, curbs, and supports shall be furnished under this Division unless otherwise indicated.
- D. The Contractor shall furnish all required foundation sizes, bolts, washers, sleeves, plates and templates for equipment.
- E. The size of the foundation bolts shall be as recommended by the manufacturer.
- F. The type and size of the supporting channels and supplementary steel shall be determined by the Contractor and shall be of sufficient strength and size to allow only a minimum, deflection in conformance with manufacturer's requirements for loading. Contractor shall submit details for approval to the Architect.

3.12 SLEEVES AND PLATES

- A. Sleeves shall be provided by the trade installing the pipe. The sleeves shall be carefully located in advance of the construction of walls and floors where new construction is involved. Provide all cutting and patching necessary to set sleeves which are not placed prior to construction. All cutting and patching necessary to set sleeves which are not placed prior to construction shall be the responsibility of the trade providing the sleeves.

- B. Sleeves shall be provided for all piping passing through concrete, masonry, plaster and gypsum wallboard construction. Caulk the annular space of pipe sleeves with an elastic caulking compound to make installation air and watertight.
- C. Fasten sleeves securely in the construction so that they will not become displaced when concrete is poured or when other construction is built around them. Take precautions to prevent concrete, plaster or other materials being forced into space between pipe and sleeve during construction.
- D. Sleeves required in existing concrete or masonry walls shall be set and secured with mortar grout and fast drying bitumastic sealant.
- E. At all sleeves where objectionable noise can be transmitted (e.g. Mechanical and Electrical Rooms), at smoke barriers, at walls above ceilings that extend to the underside of the structure of the floor above, or at fire rated separations, seal all openings between pipes and corresponding sleeves to prevent sound transmission and to maintain fire rating. Use U.L. approved resilient sealant for penetration seals.
- F. Where pipe motion due to expansion and contraction will occur, provide sleeves of sufficient diameter to permit free movement of pipe. Check construction to determine proper length for various locations; make actual lengths to suit the following:
 - 1. Terminate sleeves flush with walls, partitions and ceilings.
 - 2. Terminate sleeves 2 inches above finished floor in equipment rooms, and wet floor areas.
 - 3. In all other areas, terminate sleeves 1/2 inch above finished floor unless otherwise noted on the drawings or directed in the field.

3.13 ALTERATIONS AND DEMOLITION

- A. All existing piping, equipment and materials which are required to be removed shall be removed. All existing materials and equipment which are removed and are desired by the Owner, or are indicated to remain as the property of the Owner, shall be delivered to him on the premises by the Contractor where directed by the Architect. All other materials and equipment which are removed shall become the property of the Contractor and shall be promptly removed by him from the premises.
- B. Remove all indicated work by hand as far as possible. Power-driven equipment shall be used as a last resort, and shall not be employed without consent of the Owner. Schedule all demolition work to the satisfaction of the Owner. The Contractor shall execute the removal work as quietly as practicable to avoid unnecessary disturbances to occupied areas.
- C. Existing conditions, i.e. ductwork, piping, equipment, etc., may be obtained from available record drawings and are not warranted to be complete or correct. Contractor shall verify exact location of all ductwork, piping, etc., in the field prior to starting any work.
- D. Existing pipe sizes noted on the available record drawings are for the convenience of the Contractor only. Contractor shall verify sizes in the field.

- E. Existing piping no longer required to remain in service shall be disconnected and removed back to service mains, including existing piping hangers and supports. Existing pipe indicated or required to remain in service shall be capped.
- F. Existing piping that remains concealed, buried, or otherwise contained in or below the remaining slabs and walls shall be capped, plugged, or otherwise sealed. All pipes shall be cut so that their capped or plugged ends will be far enough behind finished surfaces to allow for the installation of the normal thickness of finished material.
- G. When existing fire protection work is removed, all related pipes, valves, and materials shall also be removed.
- H. When the work specified herein connects to existing piping, the Contractor shall perform all necessary alterations, cutting, or fitting of the existing work as may be necessary or required to make satisfactory connections between the new and existing work and to leave the completed work in a finished and workmanlike condition, to the entire satisfaction of the Architect.
- I. When the work specified herein or under other divisions of the contract necessitates relocation of existing equipment or piping, the Contractor shall perform all work and make all necessary changes to existing work as may be required to leave the completed work in a finished and workmanlike condition, to the entire satisfaction of the Architect, and at no additional cost to the Owner.
- J. Existing piping affected by removal or new work installation and required to remain in service shall be reinstalled or supported as required in accordance with new work specification. All work shall be completed to the Architect's satisfaction and at no additional cost to the Owner.
- K. Valve off or disconnect live services as required for removal work.
- L. Refer to drawings for additional requirements.

3.14 FLASHING

- A. Openings for pipes through waterproofed floors and roof areas shall be flashed.
- B. Refer to Architectural drawings and specification for additional roof flashing requirements.

3.15 COORDINATED DRAWINGS

- A. Prior to installation of fire protection work in all areas of the building including exposed areas (spaces without ceilings), the Contractor shall prepare completely coordinated layout drawings indicating the coordinated work of all trades involved. The drawings shall be a sheet size similar to the contract drawings. All work shall be to scale minimum $\frac{1}{4}" = 1" - 0"$. The drawings shall include all work shown on the drawings, including equipment, (chillers, boilers, air handling units, pumps, water heaters, storage tanks, steam generators, converters, variable frequency controllers) ATC control panels, terminal units, ductwork, air devices, dampers, piping including sprinkler and

plumbing, valves, light fixtures, electrical cable trays, raceways and conduits 2" and larger

- B. All trades shall be responsible for the preparation of the coordinated layout drawings. Each trade shall provide written certification that the coordinated drawings have accurately incorporated their work and that all conflicts are resolved or a solution is proposed on the drawings. The Contractor shall schedule the trades accordingly and shall provide final certification that all coordination has been completed.
- C. No work shall be installed prior to the Architect's approval of the drawings. The Contractor shall submit for approval of the Architect within 15 days after the award of the contract a schedule of proposed building areas to be grouped for coordination. Upon approval of the schedule, work may commence in areas of the building upon approval of that area's coordinated drawings prior to approval of another area.

3.16 CLOSE OUT PROCEDURES:

- A. Refer to Section 01 77 00 Close Out Procedures for specific requirements.

END OF SECTION 21 00 10

SECTION 21 00 50
FIRE PROTECTION BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provision of the Contract, including General and Supplementary Conditions and Division 01 specifications, apply to the work specified in this Section.

1.2 SUMMARY

- A. This section includes requirements for fire protection equipment, materials and procedures which are common to more than one section of Division 21 and which are general in nature and use. This section applies to all sections of Division 21.
- B. The requirements of Section 21 00 10, Fire Protection General Provisions, shall apply to all work specified under this section.

1.3 SUBMITTALS

- A. Submit shop drawings for all items of materials specified in this section in accordance with the Section 21 00 10.
- B. At a minimum manufacturer's product data shall include specifications, installation instructions and general recommendations for each type of material required. Include data substantiating that proposed materials comply with specified requirements for each type.

1.4 TESTS AND ADJUSTMENTS

- A. The Contractor shall furnish labor, instruments, equipments, and materials required to perform tests prescribed in the sections describing the various systems.
- B. Replace or repair defects found during inspection or test with new materials. Caulking of welded joints, screwed joints, cracks, or holes is not acceptable. Correct leaks in screwed fittings by remaking joints. In welded systems leaks in joints shall be cutout and rewelded. Repeat tests after defects have been eliminated.
- C. Where reasonable doubt exists as to a system's ability to comply with contract requirements, perform any reasonable test required by the Architect.
- D. Make static pressure tests and prove to the satisfaction of the Architect that the piping is tight before pipes are concealed or insulated. Tests shall be provided as hereinafter specified.
- E. Use test instruments for accuracy by an approved laboratory or by the instrument manufacturer and furnish certificates showing degree of accuracy to the Architect when requested. Make calibration histories for each instrument available for examination.

- F. Where gauges, thermometers and other instruments which are to be left permanently installed are used for tests, do not install until just prior to the tests to avoid possible changes in calibration.

PART 2 - PRODUCTS

2.1 HANGERS

- A. Refer to Section 21 00 10. Provide hangers and supports in accordance with requirements of NFPA 13.
- B. Hangers and accessories shall be Anvil International, Fee and Mason, Modern, National, or B-Line of the types specified in Section 21 00 10.
- C. It shall be the responsibility of the Contractor to provide an adequate pipe suspension system in accordance with recognized engineering practices, using standard, commercially accepted pipe hangers and suspension equipment.
- D. The design of all hangers and support shall be in accordance with the provision of the current issue of MSS-SP-58 document developed as a standard by the Manufacturers' Standardization Society.
- E. Hangers for steel pipe, except as noted otherwise shall be spaced at least every ten (10') feet.
- F. Where concentrated loads of valves, fittings and similar items occur, or if recommended by the piping manufacturer, closer hanger spacing will be necessary.
- G. Generally, hangers shall be clevis type, standard weight.
- H. Vibration hangers shall be provided as specified. Where required or indicated provide seismic restraint devices.
- I. Provide surge restraint as required by NFPA 13 where system working pressure exceeds 100 psi.

2.2 IDENTIFICATION AND EQUIPMENT TAGS

- A. All control devices, i.e. panels, switches, starters, push button stations, controls, etc., shall be clearly identified as to their function and the equipment controlled.
- B. All equipment such as pumps, packaged systems, etc., shall be marked to clearly identify said equipment and space or duty they serve.
- C. Equipment herein specified shall be identified using engraved laminated black and white phenolic legend plates. Letters shall be minimum, 3/4" high white on surrounding black. Plates shall be mounted by means of sheet metal screws. Submit nameplate list to Architect for approval.
- D. Piping shall be identified with colored, pre-rolled, semirigid plastic labels as manufactured by Seton, Marking Services, Inc., or approved equal. For indoor installations, labels shall be Seton "Set Mark" system. For outdoor installations, labels

shall be "Ultra Mark" system. Labels shall be set around pipes with a field installed high strength cement around pipes with a field installed high strength cement compound applied along their longitudinal edge. Labels shall be placed around the piping or insulation every forty feet (40) and with one (1) label on each pipe in rooms smaller than fifteen feet (15). A label shall be placed at every major valve and at least six feet (6) from exit or entrance to an item of equipment. At Contractor's option, piping concealed above suspended ceilings only, may be identified by stenciling with black paint and taped color bands in accordance with the coding system herein specified.

1. Labels shall be provided in accordance with the following table with color coding and stencil designations as indicated:

SIZE OF LEGEND LETTERS

<u>Outside Diameter of Pipe (Inches)</u> (Inches)	Length of Color	Size of Letters <u>Field (Inches)</u>
3/4" to 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
over 10"	32"	3-1/2"

- E. In addition to labeling as specified hereinbefore, all piping exposed within mechanical and electrical equipment spaces, utility spaces, janitor's closets, and piping elsewhere "exposed" as defined in Section 21 00 10, shall have full color coding, painted in a color identifying system type. Fire protection piping shall have additional full color coding within stairwells and at all risers. Paint colors shall conform to the following schedule:

Fire Protection	Red

- F. All valves, except as specified below, shall be provided with colored plastic or brass valve tags with stamped-in numbers. Tags shall be secured to valve wheels with metal chain. Stop valves on individual fixtures or equipment where their function is obvious, or where the fixture or equipment is immediately adjacent, need not be so equipped. Care shall be exercised in selecting valve numbers to be prepared on a drawing showing locations, details of arrangements, etc., of all service and control valves indicating identity and function. One black line print of each drawing shall be mounted under glass where directed. Valve tags shall be Seton or approved equal minimum 1-1/2" round tags with white characters describing system and valve designation. Submit valve number list for approval.

2.3 PIPE, FITTINGS, AND JOINTS

A. General

1. Piping materials shall conform to state and local code requirements. Pressurized piping systems shall conform to American National Standards Institute

- (ANSI)/American Society of Mechanical Engineers (ASME) B31.9, "Code for Pressure Piping, Building Services Piping". High-pressure piping shall conform to ANSI/ASME Section I, B31.1, "Code for Pressure Piping, Power Piping".
2. Quality and weight of materials shall comply with requirements of applicable American Society of Testing Materials (ASTM), ANSI, ASME, and Cast Iron Soil Pipe Institute (CISPI) standards. ASTM number and wall thickness shall be indicated on each pipe length.
 3. Provide pipe and fittings for systems as hereinafter specified. All references to codes shall apply to the latest year. Grooved products may be as manufactured by Victaulic or Grinnell. All piping and fittings shall be made in America.
 4. All piping shall bear a continuous repeating label along the entire length of the pipe indicating the manufacture's name, manufacture's pipe designation, pipe schedule (or wall thickness), pipe size and mark of listing agency.
 5. All fittings shall be listed and shall be installed in accordance with NFPA 13 and manufacture's recommendations.

B. Pipe Materials

1. Fire Protection Service

- a. Underground fire-suppression water-service piping 4" or larger shall be one of the following:
 - 1) Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile-or gray-iron, standard—pattern ductile-iron, compact-pattern fittings; glands, gaskets, and bolts; and gasketed joints.
OR
 - 2) Push-on-joint, ductile-iron pipe; push-on-joint, ductile-iron compact-pattern fittings; and gasketed joints.
- b. Above ground pipe 2" and below - Black steel pipe, ASTM A53A, ANSI Schedule 40, assembled with malleable iron screwed fittings class 150 or 300 ANSI B16.3.
- c. Above ground pipe 2-1/2" to 6" - Black steel pipe, ASTM A53A, ANSI Schedule 40 or Schedule 10, assembled with malleable iron screwed fittings class 150 or 300 ANSI B16.3, or welded flanged connections.
- d. Above ground pipe eight inches (8") and above – Black steel pipe, ASTM A53A ANSI Schedule 10 assembled with mechanically grooved couplings, UL listed and FM approved, Victaulic Style 107N (rigid) and Style 177 or 77 (flexible). Fittings shall be ASTM-A-395 and ASTM-A-536; ASTM-A-234 forged steel; or fabricated ASTM-A-53, or butt welded in accordance with Section 21010 paragraph 3.7.
- e. At Contractor's option (for all sizes), pipe shall be assembled with mechanically grooved couplings Victaulic Style 107N and 009N (rigid) and Style 177 (flexible) with center-leg gasket including pipe stop to ensure proper groove engagement, alignment, and pipe insertion depth. Fittings shall be Victaulic FireLock™, or approved equal ASTM-A-395 and ASTM-A-536, short-pattern with flow equal to standard pattern fittings. UL listed and FM approved for service to 300 psig with Schedule 10 pipe.
 - 1) Rigid Type: Housings cast with offsetting, angle-pattern, bolt pads to provide system rigidity and support and hanging in accordance with NFPA 13, fully installed at visual pad-to-pad offset contact. (Couplings

that require exact gapping at specific torque ratings are not permitted).

- 2) Flexible Type: For use in locations where vibration attenuation and stress relief are required.
- 3) Fittings for Schedule 40 grooved end steel piping in fire protection applications sizes 1-1/4" thru 2 1/2" shall consist of a ductile iron housing conforming to ASTM A-536, Grade 65-45-12, with prelubricated Grade "E" EPDM Type 'A' gasket; and ASTM A449 electroplated steel bolts and nuts. UL listed for working pressure of 300 psi (2065 kPa) and FM approved for working pressure 365 psi (2517kPa).

2.4 VALVES

- A. Refer to Section 21 10 00.

2.5 FIRE SERVICES VALVES

- A. Underground fire-suppression water-services shutoff valves 2" and smaller shall be corporation valves or curb valves with ends compatible with piping.
- B. Meter box fire – suppression water-service shutoff valves 2" and smaller shall be meter valves.
- C. Vault fire-suppression water-service shutoff valves 2" and small shall be Class 125, MSS, bronze, non-rising stem or UL-listed or FM Global-approved, OS&Y, bronze, gate valves.
- D. Underground fire-suppression water-service shutoff valves 3" and larger shall be one of the following:
 1. 250-psig, AWWA, iron, non-rising-stem, resilient-seated gate valves.
 2. 175-psig, UL-listed or FM Global-approved, iron, non-rising-stem gate valves.
- E. Standard-pressure, aboveground fire-suppression water-service shutoff valves 3" and larger shall be one of the following:
 1. 175-psig, UL-listed or FM Global-approved, iron, OS&Y gate valves.
 2. UL-listed or FM Global-approved butterfly valves.
- F. Fire-suppression water-service check valves 3" and larger shall be one of the following:
 1. UL-listed or FM Global-approved check valves.
 2. UL-listed or FM Global-approved detector check valves.

2.6 PIPE SPECIALTIES

- A. Pressure Gauges
 1. Gauges shall be Trerice, Ashcroft, Weiss, Winters, Crosby or Marsh equal to Trerice No. 450 series, liquid filled, 4-1/2" diameter case, bottom connected for easy reading. Dial shall have black letters on white background.

2. Pressure gauges shall be suitable for field calibration.
3. Each gauge shall be mounted within six feet of the floor on background or pipe mounted. Submit gauge locations and scale ranges for approval.
4. Provide Apollo or approved equal 1/4" ball valve where "gauge cocks" are indicated or required.
5. Select gauge such that at normal service the gauge pointer is at the middle of the scale range.

PART 3 - EXECUTION

3.1 CLEANING

- A. After completion of installation, thoroughly clean dirt, rust, loose scale, oils and grease, and other foreign matter from metal surfaces, painted or unpainted, specified under Division 21 of the specification.
- B. Clean all internal and external surfaces of the equipment. Remove all mill scale, loose metal particles, weld splatter, slag, dirt, and other foreign matter. Remove all burrs and ease all sharp edges.
- C. Flushing procedures found in NFPA 13 are to be used in flushing the system. Minimum flushing velocity is to be 10 ft. per second.
- D. Restore, to its original condition, any completed construction or construction work in progress which is not part of the work of this Specification and which is damaged during installation. All such damaged areas, which are repaired, are subject to the Architect's acceptance.

3.2 FABRICATION

- A. Sprinkler piping may be shop-fabricated in accordance with the requirements of NFPA 13.
- B. Threaded, grooved, or flanged fittings may be utilized, in accordance with the requirements of the appropriate NFPA standard, and with the requirements of this Specification.
- C. Pipe lengths are to contain the minimum number of fittings and connections practicable.
- D. Pipe may be welded at the Contractor's discretion.
 1. Conduct welding operations outside of the plant buildings, and away from hazardous locations wherever practical.
 2. When welding must be conducted inside the building, the Contractor shall establish an acceptable fabrication shop location with the Architect.
 3. Obtain permission and a welding permit from the AHJ prior to final welding of pipe.
 4. Provide a fire watch outfitted with fire hose and extinguisher during all welding operations.
 5. Comply with NFPA 13 for all welding methods and requirements.

6. Maximum length of welded section of pipe is 20 feet.

3.3 PIPING INSTALLATION

- A. Install piping without undue stress or strain in locations shown and run parallel to the lines of the building, except to grade them as specified in a neat and workmanlike manner using a minimum of fittings. Provide such fittings, valves, and accessories as may be required to meet the conditions of the installation. Contractor shall inform himself fully regarding any peculiarities and limitations of space available for installation of material under each section of specifications. Install piping to suit necessities of clearance with ducts, conduits, structure, and other work, and so as not to interfere with any passages or doorways and allow sufficient head room at all places. Use proper reducing fittings for changing piping sizes.
- B. Cut pipes accurately to measurements established in the field in a neat and workmanlike manner without damage or without forcing or springing. Perform cutting by means of an approved type of mechanical cutter of the wheel type where practicable. Ream pipe after cutting to remove all burrs.
- C. Install unions and flanges where shown and on each side of all pieces of equipment and other similar items, and in such a manner that the unions or flanges can be readily disconnected. Do not place any union or flange in a location which will be inaccessible after completion of the project. Unions or flanges for servicing and disconnect are not required in installations using grooved joint couplings.
- D. Grooved joints shall be installed in accordance with the manufacturer's latest published instructions. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service. Gaskets shall be molded and produced by the grooved coupling manufacturer. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Contractor shall remove and replace any improperly installed products.
- E. Joints between dissimilar piping material shall be made with appropriate adapters in accordance with the respective manufacturer's printed instruction and recommendations.
- F. Grade pipe minimum 1" in 40 feet to low points, unless otherwise specified or indicated. Provide drain valves at all low points.
- G. All piping shall be so installed so that it will in no way be distorted or strained by expansion or contraction.
- H. Use full pipe lengths; random lengths joined by couplings will not be accepted.
- I. All piping shall be arranged to drain to the system's main drain valve. The use of auxiliary drains for trapped sections is not acceptable unless approved in writing by the Architect. All dry or pre-action system piping that is normally filled with nitrogen shall be pitched in accordance with NFPA 13 requirements for dry pipe system piping.
- J. Piping shall not be routed directly above electrical switchgear, battery rack, electrical distribution panels, transformer, power distribution unit, or IT equipment racks.

- K. Install piping in accordance with NFPA 13 and 14.

3.4 WORKMANSHIP

- A. Cut pipes accurately to measurements established at structure. Install pipes without springing or forcing.
- B. Clear windows, doors and other openings with all pipes. Arrange pipes to permit expansion and contractions without misalignment or damage.
- C. During construction all openings in piping and equipment shall be closed with caps or plugs to keep out all foreign matter indicated.
- D. All piping in finished spaces shall be run concealed unless otherwise indicates.

3.5 WELDING

- A. Refer to Section 21 00 10

3.6 SLEEVES AND PLATES

- A. Refer to Section 21 00 10.

3.7 TESTS

- A. The following tests shall be conducted by the Contractor and all piping shall be proven tight in the presence of the Architect or his representative. Notify Architect prior to tests. These tests shall be conducted before any insulation is installed and any insulation installed prior to test shall be removed. Provide all equipment and labor required. Tests shall be at least four hours in duration. Piping may be tested in sections as approved by the Architect. Tests shall be specified herein.
- B. Fire protection piping shall be tested in accordance with NFPA 13 and 14.
- C. All pressure piping systems, unless otherwise specified herein, shall be filled with water and thoroughly flushed clean of foreign matter after erection and before connection of equipment.
- D. All centrifugal pumps shall be dynamically balanced and certified by an independent testing agency. The agency shall specialize in dynamic balancing of equipment and shall be able to demonstrate experience and expertise in dynamic documentation of all testing, including all test information as well as the certification. These documents shall become permanent records of the facility. The contractor shall be responsible to perform any alignment corrections and shall not be released of his contractual obligation until all equipment is certified to be dynamically balanced. All equipment requiring re-alignment shall be re-tested and certified. Submit name of testing company to the owner and engineer for approval.

END OF SECTION 21 00 50

SECTION 21 08 00

COMMISSIONING OF FIRE PROTECTION 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. The contractor is responsible for commissioning the systems and components in this section.
- B. The commissioning process requirements are outlined in the related sections listed below. Contractor is responsible for complying with all requirements listed therein.

1.3 RELATED SECTION

- A. Section 01 91 13 "General Commissioning Requirements" for general commissioning process requirements.

END OF SECTION 21 08 00

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SECTION 21 10 00

SPRINKLER AND STANDPIPE SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provision of the Contract, including General and Supplementary Conditions and Division 01 specifications, apply to the work specified in this Section.

1.2 SUMMARY

- A. This section includes the new fire service, wet and dry pipe sprinkler systems.
- B. The requirements of Section 21 00 10 and 21 00 50 shall apply to work specified under this section.
- C. Provide a combination wet type automatic sprinkler standpipe system where indicated and make connection to the water supply main as indicated, all in accordance with NFPA Standards 13, and Factory Mutual Standards.
- D. All requirements of the State of Delaware, State Fire Marshal's office and City and Local authorities' Fire Prevention Bureaus shall apply to this specification.

1.3 COMMISSIONING

- A. Division 21 will be responsible to carry out the commissioning requirements specified in Sections 019 1 13 and 21 08 00.

1.4 RELATED WORK SPECIFIED ELSEWHERE

- A. Meet all requirements in accordance with Section 21 00 10, Fire Protection General Provisions.
- B. Provide all piping as required by NFPA and approved plans in accordance with all applicable standards. Piping installation and hangers shall be in accordance with Section 21 00 50, Fire Protection Basic Materials and Methods, unless specified otherwise in this Section.
- C. Provide Fire pump and associated equipment and materials in accordance with section 21 30 00, Fire Pumps

1.5 CODES AND REGULATIONS

- A. All requirements of the State of Delaware, and the City and Local Fire Prevention Bureau(s), shall apply to this specification and design requirements, including the latest edition of the following codes and regulations:

Delaware State Fire Prevention Regulations
Underwriters Laboratories Fire Protection Equipment Directory
Standard for the Installation of Sprinkler Systems (NFPA 13)

Standard for the Installation of Standpipe and Hose Systems (NFPA 14)
Standard for the Installation of Centrifugal Fire Pumps (NFPA 20)
Standard for the Installation, Maintenance, and use of Protective Signaling
Systems (NFPA 72A)
Code for Life Safety from Fire in Buildings and Structures (NFPA 101)
Occupational Safety and Health Act
International Building Code
FM Global Standards

1.6 SUBMITTALS

- A. Eight (8) sets of calculations and shop drawings covering the sprinkler systems shall be prepared and submitted to the Engineer for approval prior to being submitted to any City and State agencies. All submittals required by this Specification shall be reviewed and approved by a Professional Engineer, licensed in the State of Delaware or a technician holding a NICET Level IV Certification who is experienced in the work of this Specification. This review and approval shall be performed before the submittals are provided to the Engineer. Submittals shall be signed and sealed by the qualified professional responsible for their preparation. Shop drawings shall show light fixtures, ducts, mechanical equipment, structural elements, and all other items which may affect the layout of sprinkler heads and pipes. Plans showing sprinkler work shall be not less than one-eighth inch (1/8") per foot and shall be prepared on sheets with dimensions the same as the contract drawings. No work shall be started until shop drawings are approved by all the reviewing agencies.
- B. The drawings shall indicate all areas to be sprinklered and type hazard, locations and sizes of water supply pipe, major drains and tests, zone valves and other main piping and valves, and the location of fire department connections. Complete riser diagrams shall also be submitted. The drawings shall locate by dimension all fire protection piping and sprinkler heads. The layout shall be performed by a technician holding NICET Level IV Certification or a licensed Professional Engineer. Evidence of qualifications and certification must be submitted.
- C. Provide all electrical wiring diagrams of flow switches, alarms, and supervising equipment for coordination under Division 28. All wiring shall be provided under Division 28, ELECTRICAL.

1.7 SAMPLES

- A. Submit **to** Architect if requested, samples of all sprinkler heads to be provided.

1.8 PROJECT REQUIREMENTS

- A. Layout and installation of the systems shall be accomplished by a licensed sprinkler contractor, who has been engaged in the installation of automatic sprinkler systems for a minimum of five years.
- B. A combination wet type automatic sprinkler standpipe system shall be provided for the building. The standpipe system shall be Class I in accordance with NFPA Standard 14.

- C. A dry type automatic sprinkler system shall be provided for the adjoining garage of the building in accordance with NFPA Standards. Dry pipe valves and associated equipment within the courthouse shall be provided under this project scope. Sprinkler piping and heads within the garage shall be provided under the garage contract.
- D. The building shall be fully sprinklered throughout, and the sprinkler piping systems shall be either scheduled or hydraulically designed in accordance with NFPA 13 and the Hazard Occupancy requirements of the Owner's insurance carrier. Contractor shall verify the exact design requirements with the Owner's insurance carrier. Sprinkler system shall be divided into zones as indicated on the documents.
 - 1. The sprinkler system design for mechanical equipment rooms shall be based on ordinary hazard occupancy requirements of the Owner's insurance carrier hazard occupancy requirements, whichever is more stringent. Contractor shall verify the exact design requirements with the Owner's insurance carrier.
- E. Pipe sizes shall be as required by NFPA and Factory Mutual but in no case less than those shown on the drawings.
- F. Sprinkler heads shall be provided as required by NFPA. Sprinkler head locations shall be coordinated with the architectural reflected ceiling plans. Sprinkler shop drawings shall indicate the ceiling grid, lighting fixtures, air devices, etc. Generally, sprinkler heads shall be centered in ceiling tiles.
- G. Do not interrupt existing sprinkler service to facilities occupied by Owner or others unless permitted and then only after arranging to provide temporary sprinkler service or alternate fire protection measures.
 - 1. Notify Owner no fewer than ten (10) days in advance of proposed interruption of sprinkler service
 - 2. Do not proceed with interruption of sprinkler service without Owner's written permission.
- H. All hose thread connections shall conform to the requirements of the Fire Department for compatibility with their equipment.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All sprinkler and standpipe system materials and devices shall be listed for fire protection service. Each item of equipment shall be capable of performing its function over an extended period of time with a minimum of attention and maintenance. All equipment shall be constructed using new materials designed and built in accordance with the best practices of the industry. Each major item of equipment shall bear the manufacturer's name or trademark; serial numbers; U.L. label, Factory Mutual approval; operating instructions and hydraulic temperature characteristic conditions, etc., if applicable.

- B. Unless specified otherwise, the standard manufactured products of Tyco, Viking, Victaulic, Reliable, Central, Standard, or Star shall be provided. Equipment and installation shall comply with the latest edition of NFPA Standards 13 and 14.

2.2 PIPING

- A. Provide fire protection piping systems of materials as specified in Section 21 00 50.

2.3 VALVES

A. Alarm Check Valve

1. All Alarm devices shall be listed by Underwriters laboratories and FM Global, approved for their purpose and installed according to NFPA 13. An approved alarm check valve (variable pressure type) with all the trimmings shall be installed on the system side of the main water supply control valve (Reliable model E or equivalent Grinnell, TYCO, Viking). All equipment shall be located and installed so that it is accessible for inspection, removal and repair and shall be substantially supported.
2. A retarding device shall be installed with the alarm valve arranged to permit repair or removal without shutting off water supply to sprinklers. Valves shall be arranged so that they may be locked or sealed in the open position. A valve and by-pass line shall be installed in order to test the alarm device (Alarm test). All drainage shall be arranged to the main drain.
3. The alarm check valve shall be provided with two (2) standard gauges one (1) above the alarm check for system pressure and one (1) below for supply main pressure. The system pressure gauge shall be mounted at a higher elevation than the supply main gauge.
4. The top of the retarding device or alarm line shall be fitted with approved pressure switch (Reliable Model G, Type 1, or equivalent). Conductors shall be provided under Division 16 to provide fire alarm and annunciation. Activation of the sprinkler system by one (1) sprinkler or equivalent test shall cause the fire alarm system to activate and the appropriate lamps(s) to activate on the annunciator as "water flow".

B. Check Valves

1. Check valves shall be UL listed and FM Global approved, equipped with grooved or flanged inlet and grooved outlet connections, and be approved for use on fire protection systems. Valves shall be constructed of a ductile iron body with a brass seat and a rubber faced clapper assembly hinged to a removable access cover for periodic inspection as required by NFPA 25. Valves shall have a working water pressure of 175 psi. Flanged connections shall comply with ANSI B16.1 (Class 125). Grooved connections shall comply with ANWI/AWWA C606. For vertical installations provide UL listed water check valve, 250 psi wwp.

C. Control Valves

1. OS&Y valves shall be of the double disc type, and shall have a 175 psi working pressure, unless noted otherwise. Disc rings and seats shall be bronze. Gate valves shall be capable of being repaired under pressure in the fully open

position. Valves shall be equipped with flanged ends complying with ANSI B16. (Class 125) and be provided with approved valve supervisory switches suitable for final connection to the building fire alarm system

2. Butterfly valves shall have internal gear operator hand wheel, stainless steel valve stem and be provided with a position indicator. Valves shall have a 175 psi suitable for final connection to the building fire alarm system.

D. Ball Drips

1. Ball drips shall be Elkhart Fig. No. 702 or approved equal.

2.4 FIRE DEPARTMENT VALVES

- A. Provide female by male angle, two and one-half inch (2-1/2") rough brass body three hundred-pound (300 lb.) valve with wheel handle and cap with chain. Threads shall meet Fire Department requirements. Valves shall be Potter-Roemer Fig. 4065 or approved equal. Provide Potter-Roemer Figure 1810 recessed valve cabinet where indicated on the drawings. Finish on connections shall be chrome or brushed stainless steel.

2.5 TAMPER SWITCHES

- A. All valves controlling water supply shall be electrically supervised in accordance with requirements of NFPA. Wiring necessary for the new switches shall be provided under Division 28.
 1. Provide valve supervisory switch with dual SPDT in housing with red enamel finish, 1/2-inch conduit entrance, and necessary accessories for attachment of the switch to the valve. Switch shall be provided with tamper resistant switch cover that causes supervisory contacts to close whenever the switch cover is removed.
 2. Switch shall be Potter Electric Signal Company; VSR or PS10 Series, as appropriate, or approved equal.

2.6 FLOW SWITCHES

- A. Water flow switches approved by Factory Mutual (Grimes Model VRS, VS; or equivalents) shall be installed where indicated. Conductors shall be provided under the Division 28 to provide fire alarm and annunciation. Activation of the sprinkler system by one (1) sprinkler or equivalent test shall cause the fire alarm system to activate and the appropriate lamp(s) to activate on the annunciator. An approved test shall be provided for each water flow switch
 1. Provide paddle type waterflow switch for wet pipe systems that initiate contact closure of the alarm terminal contacts whenever a flow of water greater than 10 gpm occurs downstream of the device.
 2. Switch shall be equipped with a field selectable mechanical retard feature, two independent 24-volt single pole, double throw, snap-action switches suitable for connection to the building fire alarm system. Contacts shall be screw terminal connections suitable for wiring in normally open configuration and electrically supervised by any U.L. listed fire alarm control panel.

3. Provide housing with red enamel finish, ½-inch conduit entrance, and necessary accessories for attachment of the switch to the system piping. Switch shall be provided with tamper resistant switch cover that causes supervisory contacts to close whenever the switch cover is removed.
4. Switch shall be listed Potter Electrical Signal Company; VSR or PS10 Series, as appropriate, or approved equal.

2.7 SPRINKLER PIPING SPECIALTIES

A. Flow Detection and Test Assemblies

1. Assembly shall consist of a cast or ductile iron housing with orifice, sight glass and integral test valve and be rated for 175 psig minimum.

2.8 ALARM DEVICES

A. Water Motor Alarm:

1. An outside water motor gong with guard shall be approved and installed in accordance with NFPA 13. It shall be provided with sufficient-sized piping [(minimum one inch (1"))] to cause a strong signal with one (1) Inspector's or Alarm Test open. The weather proof gong shall be cast aluminum with red-enamel factory finish, 8 ½ inches diameter, aligned as not to get out of adjustment. The gong shall be provided with a standard sign stating "SPRINKLER FIRE ALARM-CALL FIRE DEPARTMENT"
or

B. Electrically Operated Alarm Bell

1. An outside electrically operated alarm bell shall be approved and installed in accordance with NFPA 13. Unit shall be a vibrating metal alarm bell, 8 inch diameter with Red enamel factory finish, suitable for outdoor use.

2.9 SPRINKLERS

- A. Sprinklers shall be listed by Underwriter's Laboratories and only new sprinklers shall be used. Any sprinkler that incurs damage, is painted, or is sprayed with any fire retardant or obstructive material shall be replaced at no cost to the Owner. Sprinklers shall be provided and installed in accordance with NFPA 13 and Factory Mutual and properly coordinated with other work including duct and light fixture installation. The correct type of sprinkler head shall be used in every location.
- B. The correct temperature rating of every sprinkler head shall be used according to the maximum ceiling temperature rating and requirements in NFPA 13. All sprinklers with the exception of specified decorative types shall have their frame arms colored at the factory in accordance with the standard table in NFPA 13.
- C. Sprinklers that may be subject to mechanical damage due to their location (under stairwells, or low hanging sprinklers in corridors, storage rooms or under ducts) shall be provided with approved guards (Victaulic Model V27/V34 or equivalent). Sprinklers under open gratings shall be provided with approved shields.

- D. Exposed sprinklers in the detention area and connecting corridors (with no ceilings) shall be provided with approved guards (Victaulic Model V27/V34 or equivalent).
- E. Sprinkler heads shall be provided as follows:
 - 1. In suspended tile or plaster ceilings, provide concealed sprinkler heads, Viking VK302, or approved equal. Sprinkler cover shall match the adjacent ceiling as to color.
 - 2. Sidewall sprinkler heads shall be Viking VK305 or approved equal.
 - 3. All exposed heads in suspended ceiling shall be chrome plated. All others shall be brass.
 - 4. Where piping is exposed, provide brass sprinkler heads, provide Viking Model M quick response, Viking VK300 or VK302, Victaulic V27/34, or approved equal, pendent or upright as required.
 - 5. Dry type sprinkler heads installed within plaster ceilings shall be concealed quick response type, TYCO DS-ECC2 or equal.
 - 6. Dry type sprinkler heads installed in exposed areas shall be upright pendant type sprinkler heads, TYCO DS-1 or equal.
 - 7. Sprinkler heads in the detention area and where otherwise indicated shall be institutional quick response flush pendant sprinklers, Tyco Raven 5.6K, or approved equal. Escutcheon closure plates shall be white.
 - 8. All exposed heads in suspended ceiling shall be chrome plated. All others shall be brass.
 - 9. A stock of spare sprinklers shall be turned over to the Owner at the final acceptance test. The spare sprinklers shall be cabinet mounted and shall include all types and temperature ratings installed. The number of spare heads shall correspond to the number of spare sprinklers required in NFPA 13 for each type and temperature.

2.10 FIRE DEPARTMENT ROOF CONNECTION

- A. The hose connection shall be a rough brass standpipe roof outlet with [two (2)] and one-half inch (2-1/2") outlets with threads conforming to the National (American) Standard Fire Hose Coupling Screw Threads equipped with screw caps and chains. Connection shall be Allen, Badger-Powhattan, Elkhart, Potter-Roemer, or Seco equal to Potter-Roemer 5845 Series. Roof connection shall be controlled by an inline U.L. approved gate valve with non-rising stem equipped with a free-standing type valve extension system equal to Potter-Roemer 5855 Series. Refer to drawings for details.

2.11 DRY PIPE SPRINKLER SYSTEM

- A. A dry pipe sprinkler system shall be provided where indicated on plans. The system shall be designed and installed in accordance with NFPA 13 and shall include all components required for a complete functioning system.
- B. Manually operated sprinkler control valve and gate valve. The valve shall be outside stem and yoke type.
- C. Check valve shall be of the swing type with flanged cast iron body and flanged inspection plate.

- D. The dry pipe valve shall be a latching differential type listed in accordance with UL Fire Protection Directory and shall be complete with trim piping, valves, fittings, pressure gauges, priming water fill cup, velocity drip check, drip cup, and other ancillary components as required for proper operation. The assembly shall include a quick-opening device by the same manufacturer as the dry pipe valve.
- E. The air supply system shall be in accordance with NFPA 13. The connection pipe from the air compressor shall not be less than ½" diameter and shall enter the system above the priming water level of the dry pipe valve. A check valve shall be installed in the system supply air piping from the compressor. A shut-off valve of the renewable disc type shall be installed upstream of the check valve. The air supply system shall be sized to pressurize the sprinkler system to 40 psi within 20 minutes.
- F. The air compressor shall be a single stage, oil-free type, air-cooled, electric motor driven, equipped with a check valve, shut-off valve and pressure switch for automatic starting and stopping. Pressure switch shall be factory set to start the compressor at 30 psi and stop it at 40 psi. A safety relief valve, set to operate at 654 psi shall be provided.
- G. The air pressure maintenance device shall be a pressure regulator that automatically reduces supply air to provide the pressure required to be maintained in the piping system. This device shall have a cast bronze body and valve housing complete with diaphragm assembly, spring, filter, ball check to prevent backflow, 1/16" restriction to prevent rapid pressurization of the system, and adjustment screw. The device shall be capable of reducing an inlet pressure up to 100 psig to a fixed outlet pressure adjustable to 10 psi.
- H. The system shall be configured so that each dry pipe system is equipped with a separate pressure maintenance device, air compressor, shut-off valve, by-pass valve and pressure gauge. Piping shall be galvanized steel in accordance with ASTM A795M or ASTM A53/A53M.
- I. Each dry pipe valve trim shall be provided with a local alarm device consisting of a metal enclosure containing an alarm horn or bell, silence switch, green power-on light, red low-air alarm light and amber trouble light.
- J. An electrically operated, exterior-mounted, water flow alarm bell shall be provided and installed in accordance with NFPA 13. Water motor alarm assembly shall include a body housing, impeller or pelton wheel, drive shaft, striker assembly, gong, wall plate, and related components necessary for complete operation.
- K. The system shall include the following alarm initiating and supervisory devices:
 - 1. Sprinkler pressure (waterflow) alarm switch.
 - 2. Low air pressure supervisory switch.
 - 3. Valve supervisory (tamper) switch.
- L. Air Compressor:
 - 1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

2. Motor Horsepower: Fractional.
 - i. Power: 120 V ac, 60 Hz, single phase.
3. Sized for application and capable of achieving system supervisory pressure within 30 minutes in accordance with requirements of NFPA 13. Provide ASME air receiver tank as required to meet requirements on larger systems. Provide system capacity calculations to validate the selected compressor size. Selections must take into consideration the largest capacity dry sprinkler zone supplied by the compressor in addition to the combined total capacity of all dry sprinkler zones supplied from each compressor.
4. Include filters, relief valves, coolers, automatic drains, and gauges.
5. Minimum Capacity: Match capacity of nitrogen generator.

M. BAS Alarm Integration:

1. Provide nitrogen generation system with integrated leak detection and bypass alarms. Program alarms into controller and connect to building automation system.
 - i. Leak detection system is to alarm if leaks develop within fire suppression system piping.
 - ii. Air bypass alarm is to alarm if nitrogen generation system is bypassed by air compressor.

2.12 FIRE EXTINGUISHER

- A. Provide ten (10) pound dry chemical fire extinguisher(s) in mechanical equipment rooms(s) where indicated or required. Extinguishing agent shall be suitable for fires involving class A, B, and C materials. Extinguisher(s) shall be Sentry Model SY-1014 with mounting bracket or approved equal by Kidde or Ansul.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

3.2 SERVICE-ENTRANCE PIPING

- A. Connect sprinkler piping to water-service piping for service entrance to building.
- B. Install shutoff valve, backflow preventer, pressure gauge, and drain at connection to water service.

3.3 PIPING INSTALLATION

- A. Install piping as indicated on approved shop drawing submittals.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
 2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- B. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13, 14, FM Global Standards, and authorities having jurisdiction.
- C. Use listed fitting to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- D. Install unions adjacent to each valve in pipes 2" and smaller.
- E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having 2-1/2" and larger end connections.
- F. Install "inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- G. Install sprinkler piping with drains for complete system drainage.
- H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- I. Install automatic (ball drip) drain valve at each check valve for fire-department connection to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- J. Install alarm devices in piping systems.
- K. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
1. Provide pipe hangers and supports for fire protection piping as hereinbefore specified in Section 21 00 50, and in no case less than the requirements of NFPA.
 2. All sprinklered piping shall be substantial supported from the building structure which must support the total load of the water filled pipe plus a minimum of two hundred fifty pounds (250 lbs.) applied at the point of hanging in accordance with NFPA 13. All hanging apparatus and equipment shall be of an approved type installed in accordance with NFPA 13.
- L. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than 1/4" and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.
- M. Pressurize and check dry pipe sprinkler system piping and air-pressure maintenance

devices air compressors.

- N. Fill wet pipe sprinkler system piping with water.
- O. Install sleeves for piping penetrations of walls, ceilings, and floors.
- P. Install escutcheons for piping penetrations of walls, ceilings, and floors.
- Q. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1 Cut thread 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 compounds to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- R. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators.
 - 1. Shop weld pipe joint where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- S. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join Steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- T. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.
- U. Install listed fire-protection shutoff valves supervised open located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve. Valves shall be painted red.
- V. Install backflow preventers in water-supply sources.
- W. The work under this Section shall be coordinated with that of all other sections and trades so that all work may be installed in the most direct and workmanlike manner and so that interference between piping, ducts, equipment, architectural and structural features will be avoided.
- X. Sprinkler heads shall be located away from electrical gear, including switchgear, transformers, panelboards, cable racks, UPS's, etc.
- Y. Piping shall run concealed in areas of drop ceilings. Piping shall be installed and arranged to protect it from freezing and corrosion, and shall be pitched for drainage. Installation of all piping shall be in coordination with ducts, light fixtures, and any other work that may obstruct sprinklers.
- Z. Drains and test piping shall be furnished and installed so that all parts of the system may be drained and tested properly. Piping shall not be exposed to freezing. All risers shall be equipped with drains with sizes as specified in NFPA 13.

1. All interior sectional control valves including riser control valves shall be provided with auxiliary drainage so located as to drain that portion of the system controlled by the sectional valve. These drains shall discharge either outside, to drain connection leading to the main drain, or to a drain system. Obtain approval of all discharge locations.
2. Auxiliary drains shall be provided to properly drain points of the system when a change in direction prevents drainage.

AA.A test pipe(s) of not less than one-inch (1") diameter, terminating in a smooth bore corrosion resistant outlet, giving a flow equivalent of one (1) sprinkler shall be provided (Inspector' test). The test pipe shall be in the top level of sprinklers, piped from the end of the most remote branch line and discharged outside the building including a forty-five degree (45°) elbow pointed downward at a point where it can be readily observed. Obtain Engineer's approval for each discharge location.

3.4 IDENTIFICATION

- A. Identification signs similar to or the same as those recommended in NFPA 13 shall be affixed securely by chain to all valves. The signs shall be red in color (Reliable Model A, Style A and B or equivalent.) Riser drains shall read "RISER DRAIN" or "DRAIN". Auxiliary drain signs shall be labeled "AUXILIARY DRAIN". Inspector's Test's signs shall be labeled "INSPECTORS TEST".
- B. An identification nameplate similar to or the same as those recommended in NFPA 13 and shall be affixed securely by chain. Locate at sprinkler zone piping connection to existing standpipe riser. Nameplate shall be Seton style SPH indication the location and basis of design including design density and discharge area.

3.5 INSTALLATION, TESTS, AND ACCEPTANCE

- A. Installation, tests, and acceptance shall be in accordance with all applicable codes and authorities.
- B. Installation shall be in accordance with all applicable coeds. Installation of equipment and devices that pertain to other work in the contract shall be closely coordinated with the appropriate subcontractors.
- C. The complete installation shall be inspected by a technician holding a NICET Level IV Certification before the hydrostatic test is performed.
- D. All required tests shall be performed by the installer (contractor). The Contractor shall see that proper representative of the Owner, the Engineer, and any other authority having jurisdiction desiring to witness the test shall be notified at least forty-eight hours (48 hrs.) ahead of the scheduled test times. The following tests shall be witnessed:
 1. Lead-in connections to the system shall be flushed before connection is made to any system piping using the criteria required in NFPA 13.
 2. All piping shall be tested hydrostatically at not less than two hundred psi (200 psi) for two hours (2 hrs.). The hydrostatic test pressure shall be measured at the low point of the system. The hydrostatic test shall be for the entire system as installed and specified.

3. All alarm equipment, drainage facilities, inspector's test, etc., shall be operated while the control valves are wide open. The main drain shall be opened and remain open until the system pressure stabilizes. All air shall have been bled from the system at the top inspector's test connection prior to these tests.
 4. The contractor shall furnish a written statement to the effect that all work covered in the contract has been completed and tested in accordance with the approved specifications and plans. Copies of the written statement shall be provided to the Owner and any other authority having jurisdiction.
 5. An air supply test must be performed to confirm that normal air pressure can be restored within 30 minutes for the preaction system assembly.
- E. The following materials shall be furnished by the Contractor at the conclusion of the final acceptance test:
1. Operating and maintenance instruction in accordance with Section 21 00 10.
 2. The spare sprinklers hereinbefore specified.
 3. Any and all special tools noted by the manufacturer required for the fire protection items furnished.
- F. After completion of installation and tests clean interior and exterior surfaces of equipment and materials, painted or unpainted installed under this section of specification of dirt, rust, loose scale, oils, grease and other foreign matter.

END OF SECTION 21 10 00

SECTION 21 31 13

ELECTRIC-DRIVE, CENTRIFUGAL FIRE PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Horizontally mounted, single-stage, split-case fire pumps.
 - 2. Fire-pump accessories and specialties.
 - 3. Flowmeter systems.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rated capacities, operating characteristics, performance curves, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For fire pumps, motor drivers, and fire-pump accessories and specialties.
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of fire pump, from manufacturer.
- B. Source quality-control reports.
- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire pumps to include in operation and maintenance manuals.

1.6 WARRANTY

- A. Provide 5-year extended manufacturer warranty.
- B. The warranty period shall start at the date of overall substantial completion for the project.
- C. Submit a sample warranty for approval before purchasing equipment.
- D. See section 01 77 00 – Closeout Procedures for additional warranty requirements.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Comply with NFPA 20.
 - 1. Component Importance Factor: 1.5.
- B. Pump Equipment, Accessory, and Specialty Pressure Rating: 175 psig (1200 kPa) minimum unless higher pressure rating is indicated.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 HORIZONTALLY MOUNTED, SINGLE-STAGE, SPLIT-CASE FIRE PUMPS

- A. Provide Peerless pump model 4AEF10-SLT or approved equal.
- B. Pump:
 - 1. Standard: UL 448 for split-case pumps for fire service.
 - 2. Casing: Axially split case, cast iron, with ASME B16.1 pipe-flange connections.
 - 3. Impeller: Double suction, cast bronze, statically and dynamically balanced, and keyed to shaft.
 - 4. Wear Rings: Replaceable bronze.
 - 5. Shaft and Sleeve: Alloy steel shaft with bronze sleeve.
 - a. Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
 - b. Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.

- 6. Mounting: Pump and driver shafts are horizontal, with pump and driver on same base.
- C. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
- D. Driver:
 - 1. Standard: UL 1004A
 - 2. Type: Electric motor; NEMA MG 1, polyphase Design B.
- E. Capacities and Characteristics:
 - 1. **Rated Capacity: 500 gpm**
 - 2. **Total Rated Head: 70 psi.**
 - 3. **Motor Horsepower: 40 hp.**
 - 4. **Motor Speed: 3550 rpm.**

2.3 FIRE-PUMP ACCESSORIES AND SPECIALTIES

- A. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump casing.
- B. Circulation Relief Valves: UL 1478, brass, spring loaded; for installation in pump discharge piping.
- C. Relief Valves:
 - 1. Description: UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water-supply piping.
- D. Inlet Fitting: Eccentric tapered reducer at pump suction inlet.
- E. Outlet Fitting: Concentric tapered reducer at pump discharge outlet.
- F. Hose Valve Manifold Assembly:
 - 1. Standard: Comply with requirements in NFPA 20.
 - 2. Header Pipe: ASTM A 53/A 53M, Schedule 40, galvanized steel, with ends threaded according to ASME B1.20.1.
 - 3. Header Pipe Fittings: ASME B16.4, galvanized cast-iron threaded fittings.
 - 4. Automatic Drain Valve: UL 1726.
 - 5. Manifold:
 - a. Test Connections: Comply with UL 405; however, provide outlets without clappers instead of inlets.
 - b. Body: Flush type, brass or ductile iron, with number of outlets required by NFPA 20.
 - c. Nipples: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe, with ends threaded according to ASME B1.20.1.

- d. Adapters and Caps with Chain: Brass or bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
- e. Escutcheon Plate: Brass or bronze; rectangular.
- f. Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads. Include caps and chains.
- g. Exposed Parts Finish: Rough Brass.
- h. Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

2.4 FLOWMETER SYSTEMS

- A. Description: UL-listed or FM-Approved, fire-pump flowmeter system able to indicate flow to not less than 175 percent of fire-pump rated capacity.
- B. Pressure Rating: 175 psig minimum
- C. Sensor: Annubar probe, orifice plate, or venturi unless otherwise indicated. Sensor size shall match pipe, tubing, flowmeter, and fittings.
- D. Permanently Mounted Flowmeter: Compatible with flow sensor; with dial not less than 4-1/2 inches in diameter. Include bracket or device for wall mounting.
 - 1. Tubing Package: NPS 1/8 or NPS 1/4 soft copper tubing with copper or brass fittings and valves.
- E. Portable Flowmeter: Compatible with flow sensor; with dial not less than 4-1/2 inches in diameter and with two 12-foot- long hoses in carrying case.

2.5 GROUT

- A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink and recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.6 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect fire pumps according to UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."
 - 1. Verification of Performance: Rate fire pumps according to UL 448.
- B. Fire pumps 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 equipment bases and anchorage provisions, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of fire pumps.
- B. Examine roughing-in for fire-suppression piping systems to verify actual locations of piping connections before fire-pump installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Fire-Pump Installation Standard: Comply with NFPA 20 for installation of fire pumps, relief valves, and related components.
- B. Equipment Mounting:
 - 1. Comply with requirements for vibration isolation devices specified in Section 21 05 48.13 "Vibration Controls for Fire-Suppression Piping and Equipment."
- C. Install fire-pump suction and discharge piping equal to or larger than sizes required by NFPA 20.
- D. Support piping and pumps separately, so weight of piping does not rest on pumps.
- E. Install valves that are same size as connecting piping. Comply with requirements for fire-protection valves specified in Section 21 00 50.
- F. Install pressure gages on fire-pump suction and discharge flange pressure-gage tappings. Comply with requirements for pressure gages specified in Section 21 00 50.
- G. Install piping hangers and supports, anchors, valves, gages, and equipment supports according to NFPA 20.
- H. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.
- I. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

3.3 ALIGNMENT

- A. Align split-case pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.

- B. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.
- C. Align piping connections.
- D. Align pump and driver shafts for angular and parallel alignment according to HI 1.4 and to tolerances specified by manufacturer.

3.4 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to pumps and equipment to allow service and maintenance.
- C. Connect relief-valve discharge to drainage piping or point of discharge.
- D. Connect flowmeter-system meters, sensors, and valves to tubing.
- E. Connect fire pumps to their controllers.

3.5 IDENTIFICATION

- A. Identify system components. Comply with requirements for fire-pump marking according to NFPA 20.

3.6 FIELD QUALITY CONTROL

- A. Test each fire pump with its controller as a unit. Comply with requirements for electric-motor-driver fire-pump controllers specified in Section 26 29 33 "Controllers for Fire-Pump Drivers."
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections
 - 1. After installing components, assemblies, and equipment, including controller, test for compliance with requirements.
 - 2. Test according to NFPA 20 for acceptance and performance testing.
 - 3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- D. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.
- F. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Hoses are for tests only and do not convey to Owner.

3.7 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain fire pumps.

END OF SECTION 21 31 13

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SECTION 22 00 10

PLUMBING GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provision of the Contract, including General and Supplementary Conditions and Division 01 specifications, apply to the work specified in this Section.

1.2 SUMMARY

- A. This section describes the general provisions for the mechanical and electrical work included in Division 22. This section applies to all sections of Division 22.

1.3 RESPONSIBILITY

- A. The General Contractor shall be responsible for all work included in the Plumbing Division and the delegation of work to Subcontractors shall not relieve him of this responsibility. Subcontractors who perform work under these Sections shall be responsible to the General Contractor. The term "Contractor" is used throughout this Division and shall mean the General Contractor, although the actual performance of the work may be by a Subcontractor.

1.4 REFERENCES AND DEFINITIONS

- A. Following are definitions of terms and expressions used in the Plumbing Sections in addition to those included in Division 01 Sections:
 - 1. Owner: State of Delaware, OMB / DFM
 - 2. Architects: Tevebaugh Architecture
 - 3. Engineers: WSP USA Buildings Inc.
 - 4. Directed - "directed by the Architect"
 - 5. Indicated - "indicated or in Contract Documents"
 - 6. Concealed - "hidden from normal sight"; includes items in shafts, pipe and duct spaces, and above ceilings.
 - 7. Exposed - "not concealed" - Work within Equipment Rooms and all visible (normal sight) work shall be considered exposed".
 - 8. Piping - includes pipes, fittings, valves, hangers and accessories comprising a system.

1.5 STANDARD SPECIFICATION

- A. References to catalogs, standards, codes, specifications, and regulations are the latest edition in effect at date of invitation to bid.

1.6 CODES, REGULATIONS AND PERMITS

- A. Give all necessary notices and obtain all required permits. Pay all fees and other costs, including utility connections or extensions in connection with the work. File all necessary plans, prepare all documents and obtain all necessary approvals of all governmental departments having jurisdiction. Obtain all required certificates of inspection and deliver same to the Architect before request for acceptance and final payment for the work.
- B. All materials furnished and all work installed shall comply with the latest rules, regulations, and recommendations of the following bodies:

ICC International Building Code (IBC 2018)

ICC International Mechanical Code (IMC 2018)

ICC International Plumbing Code (IPC 2018)

Delaware State Fire Prevention Code

NFPA 13, Sprinkler Systems

NFPA 70, The National Electrical Code

NFPA 90A, Installation of Air Conditioning and Ventilating Systems

The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Handbooks

1.7 MATERIALS LIST AND SHOP DRAWINGS

- A. See General Requirements.
- B. Refer to section 01 33 00 "Submittal Procedures" for submittal requirements and procedures.
- C. After receiving approval of equipment manufacturers and prior to delivery of any material to job site and sufficiently in advance of requirements to allow the Architect ample time for checking, submit for approval dimensioned drawings or cuts showing construction size, arrangement, operating clearances, performance characteristics and capacity of materials and equipment. Each item of equipment proposed shall be a standard catalog product of the approved manufacture.
- D. Samples, drawings, specifications, catalogs, etc., submitted for approval shall be properly labeled indicating specific services for which material or equipment is to be used, section and article number of specifications governing, and Contractor's name, name of job, and date.
- E. Catalogs, pamphlets or other documents submitted to describe items on which approval is being required shall be specific and identification in catalog, pamphlet, etc., of the item submitted shall be clearly made in ink. Data of a general nature will not be

accepted. Any deviations or exceptions taken is the specification by the Contractor shall be so noted.

- F. Any deviations or exceptions taken in the specification by the Contractor shall be so noted.
- G. If material or equipment is installed prior to receipt by the Contractor of approved shop drawings, marked "Approved", "No Exception Taken" or "Make Corrections Noted", the Contractor shall be liable for its removal and replacement at no extra charge to the Owner.
- H. The acceptance of shop drawings shall not relieve the Contractor from his responsibility to furnish material, equipment and systems and to perform work required by the contract documents. Neither the Owner nor the Architect will be responsible for errors or omissions on shop drawings furnished by the Contractor even though such shop drawings containing errors or omissions are inadvertently accepted.
- I. The Contractor is further advised that the Architect will not act as coordinator between suppliers and subcontractors. All required coordination shall be the responsibility of the Contractor.

1.8 CONTRACTOR'S USE OF CAD/REVIT FILES

- A. At the Contractor's written request, copies of the Engineer's CAD / Revit files may be made available for Contractor use in connection with the project, subject to following conditions:
 - 1. Submit written request to the Architect listing the specific drawings the Contractor intends to use. Provide a specific list of submittals that the files will be used in preparing, and the list of names of subcontractors or suppliers.
 - 2. The Contractor shall request in writing the electronic transfer agreement. Prior to transfer of files, the Contractor shall prepare a separate electronic transfer agreement for each subcontractor or supplier who will be using the electronic files.
 - 3. Data contained on the electronic files is part of Leach Wallace Associates (LWA) instruments of service and shall not be used for any purpose other than as a convenience in the preparation of shop drawings for the referenced project. Any other use or reuse will be at the Contractor's sole risk and without liability or legal exposure to LWA.
 - 4. The electronic files are not contract documents. Significant differences may exist between the electronic files and the corresponding hard copy contract documents. Because of the possibility the information and data delivered in machine readable form may be altered, whether inadvertently or otherwise, LWA reserves the right to retain hard copy originals of the electronic documentation delivered to the contractor, in machine readable form, which the original shall be referred to and shall govern in the event of any inconsistency between the two.
 - 5. The use of the electronic files, does not relieve the Contractor of their duty to fully comply with the contract documents, including and without limitation, the need to check confirm and coordinate all dimensions and details, take field measurements, verify field conditions and coordinate work with that of other Contractors for the project.

6. All "internal" calculations integral to / performed by the Revit model shall not be utilized for any purpose by the Contractor. This includes, but shall not be limited to, voltage drop calculations, duct static pressure calculations, air system airflow summary calculations, piping system pressure drop calculations, etc.
7. All Revit "families" are the property of LWA and shall not be re-used on any other project for any purpose by the Contractor.

1.9 GUARANTEE

- A. The Contractor guarantees by his acceptance of the Contract that all work provided shall be free from defects in workmanship and materials for a period of two years after date of substantial completion. Any defects in workmanship, materials or performance which appear within the guarantee period shall be corrected by the Contractor without cost to the Owner within a reasonable time to be specified in notice from the Architect. In default thereof, Owner may have such work done and charge the cost of same to the Contractor.

1.10 SITE VISIT

- A. Prior to preparing the bid, the plumbing subcontractors shall visit the site and familiarize themselves with all existing conditions. Make all necessary investigations as to locations of existing equipment, ductwork, piping, utilities, etc., work to be removed, and all other matters which can affect the work under the Contract. No additional compensation will be made to the contractor as result of his failure to familiarize himself with the existing conditions under which the work must be performed.
- B. Refer to Section 00 21 13 Instructions to Bidders, and Section 00 22 13 Supplementary Instructions to Bidders.

1.11 DRAWINGS

- A. The contract drawings are diagrammatic and indicate the general arrangements of systems and work included in the Contract. Do not scale the drawings. Consult the architectural and structural drawings and details for exact location of structure and equipment; where same are not definitely located, obtain this information from the Architect.

1.12 RECORD DRAWINGS

- A. The Contractor shall keep accurate records of all deviations in work are actually installed from work indicated. One complete set of contract documents shall be available at the construction site for indicating said deviations.
- B. When work is complete, make one (1) complete "As-Built" set of PDF files, certifying the accuracy of each drawing by endorsement and signature thereon and deliver to the Architect who will, after approval, deliver the record drawings to the Owner.
- C. Refer to Section 01 78 39 Project Record Documents for specific requirements.

1.13 OPERATING AND MAINTENANCE INSTRUCTIONS:

- A. Contractor shall furnish to the Architect two (2) complete bound sets of typewritten or blueprinted instructions and one (1) PDF set for operating and maintaining all systems and equipment included in this Contract. Each set of instructions shall be contained in a hard-back ring binder properly indexed and labeled. Also provide two complete bound sets and one PDF set of approved shop drawings for all items of equipment utilized on the project. All instructions shall be submitted in draft for approval prior to the final issue. Manufacturers' advertising literature or catalogs will not be acceptable for operating and maintenance instructions.
- B. Contractor shall prepare Operation and Maintenance Data and submit in accordance with the requirements of Section 01 78 23 Operation and Maintenance Data.
- C. Instructions shall include a general description of each system together with specific instructions describing routine and emergency procedures required of the building maintenance personnel for operating and maintaining each system. The instructions shall include the name or label, location, and function of all operating equipment and controls, and the location of the electrical service and breaker I.D. numbers. Operating modes and the procedures for indexing each mode shall be clearly described. Include lubrication charts and schedules of frequency of lubrication for all equipment designating each point of lubrication and type of lubricant to be used. A listing of names, addresses, and phone numbers of the service organizations for each item of equipment and a typewritten maintenance schedule for same shall be included.
- D. Upon completion of all work and of all tests, at a minimum the Contractor shall furnish the necessary skilled labor and helpers for operating the systems and equipment for a minimum period of two (2) days of eight hours each, or as otherwise specified. Instruct the Owner's representative fully in the operating, adjustment and maintenance of all equipment furnished. Instruction shall be divided into four (4) sessions of four hours each, each at a time directed by the Owner. Refer to section 01 79 00 Demonstration and Training for specific requirements. Refer to individual specification Sections for additional training requirements.
- E. The instructors shall be thoroughly familiar with all parts of the installation on which he is to give instruction and shall be trained in operating theory as well as practical operation and maintenance work. Employ factory trained instructors wherever necessary as determined by the Architect.
- F. During the guarantee period, the Contractor shall service all major equipment items provided under this contract, including Domestic water heaters, domestic booster pumps, which require outside service agencies. Service shall not include filter replacement, lubrication of motors and bearings or continuation of water and special system chemical treatment after formal acceptance of the systems by the Architect. Prior to the start of guarantee period, the Contractor shall provide the Architect with a schedule of required maintenance operations for each item of equipment. Submit schedule to the Architect for approval. Thereafter, monthly reports shall be submitted to the Owner for describing actual service provided. Forty-eight (48) hours advance notice shall be given to Owner prior to work required under this Section.

1.14 ELECTRICAL WORK:

- A. Under Division 22 Plumbing, provide the following items of electrical work which shall conform with the applicable requirements of the Electrical Division:
 - 1. Control wiring.
 - 2. Interlock wiring for plumbing equipment.
- B. Under Division 26, 27 or 28, provide:
 - 1. Power wiring complete from source to motor or equipment junction box, including power wiring through motor starters.
 - 2. Motor control centers or motor starter panelboards.
 - 3. All miscellaneous individual motor starters, local wall mounted control devices, unless noted or specified otherwise.

1.15 EQUIPMENT STARTUP AND INITIAL OPERATION

- A. No equipment shall be operated for testing or trial use except after full compliance with the equipment manufacturers' specifications and instructions of the lubrication, alignment direction of rotation, balance, and other applicable considerations.
- B. Particular care shall be taken to see that all equipment is completely assembled and properly lubricated and all grease and oil cases and reservoirs have been filled to the correct level with the recommended lubricant.
- C. It is the Contractor's responsibility to place each item of equipment installed by him in operating condition, including all auxiliaries, piping, wiring, etc., and to start up each unit and check it for performance.

1.16 FIRE PROTECTION:

- A. As minimum, one five-pound CO2 extinguisher shall be provided with each work crew at all times when working within the building.

1.17 SCHEDULE OF WORK:

- A. Refer to project schedule. Specific phasing requirements are to be incorporated into the project schedule. Contractor shall coordinate all work included in this division.

1.18 SERVICE AGENCIES:

- A. All plumbing equipment suppliers shall have an established authorized service agency located within the local area. Within 30 days after award of the Contract, the Contractor shall submit to the Architect for approval a list of manufacturers' material and equipment names, including their respective service agency, he proposes to use. In the event any service agency in the list fails to comply with the specification requirement, such service agency will be rejected.

1.19 SINGULAR NUMBER

- A. Where any device or part of equipment is herein referred to in the singular number (such as "valve"), such reference applies to as many such devices as are required to complete the installation, shown, implied or otherwise, as indicated on the drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All materials shall be new, the best of their respective kinds, suitable for the conditions and duties imposed on them at the building and shall be of reputable manufacturers. The description, characteristics, and requirements of materials to be used shall be in accordance with qualifying conditions established in the sections following.
- B. Refer to Division 01 for General Requirements.
- C. All component parts of each item of equipment or device shall bear the manufacturers' name plate, giving name of manufacturer, description, size, type, serial or model number, electrical characteristics, etc, in order to facilitate the maintenance or replacement. The name plate of a subcontractor or distributor will not be acceptable. All equipment requiring electrical service shall be U.L. labeled, or if a U.L. label is not available from the manufacturer, the equipment shall be tested by an approved electrical testing company in accordance with NEC, and at no additional cost to the Owner. Submit data indicating compliance with standards prior to installation.
- D. In specifying materials, four general procedures are used. The four classifications are as follows:
 - 1. GROUP 1: When the material or equipment is specified by name of the identifying information and one name brand only is used, it is considered that the use of that particular item is essential to the project, and the Contractor shall base his proposal on the uses of that item.
 - 2. GROUP 2: When a material or equipment is specified by brand name and other identifying information and two or more brand names are named, it is considered that any one of the brands so named will be performed as desired, and the Contractor shall base his proposal on one of the named brands.
 - 3. GROUP 3: When the material or equipment is specified with the phrase "...or equal..." after a brand name and other identifying information, it is intended that the brand name is used for the purpose of establishing a minimum acceptable standard of quality and performance and Contractor may base his bid proposal on any item which is in all respects equal to that specified and presents essentially the same appearance, size, operation and performance. The Contractor shall be responsible for coordination of the equal product.
 - 4. GROUP 4: When material is specified as complying with the requirements of published "Standard Specification" of trade associations, American Society for Testing and Material, government specifications, etc., the Contractor shall base his proposal on any item which can be shown to comply in all respects to the referred to "Standard Specification".
- E. All substitutions shall be submitted in accordance with Section 01 25 00 Substitution Procedures. It is distinctly understood: (1) that the Architect will use his own judgment in determining whether or not any materials, equipment or methods offered in

substitution are equal to those specified and will fit within the space available; (2) that the decision of the Architect on all such questions of equality is final; and (3) that all substitutions will be made at no increases in cost to the Owner.

- F. Upon receipt of written approval from the Architect, Contractor may proceed with substitution providing the Contractor assumes full responsibility for and makes, at his expense, any change or adjustment in construction or connection with any work that may be required by the substitution of such materials, equipment or methods. In the event of any adverse decisions by the Architect, no claim of any sort shall be made or allowed against the Owner.

2.2 PIPING SUPPORTS, GENERALLY

- A. Piping shall be run parallel with the lines of the building unless otherwise shown or noted on drawings. The different service pipes, valves, and fittings shall be so installed that after the covering is applied there will not be less than 1/2 inch clear space between the finished covering of parallel adjacent pipes. Hangers on different service lines running parallel with each other and nearly together shall be in line with each other and parallel to the lines of the building. Exact location of electric outlets, piping, ducts, and conduits shall be coordinated among the trades so that there will be no interference between lighting fixtures, piping, ducts, and conduits. Where conflicts between the trades result, they shall be resolved by the Contractor to the Architect's satisfaction and at no expense to the Owner.
- B. In general, hangers shall be spaced so as to prevent sag and permit proper drainage and shall not be spaced more than 10 feet apart unless otherwise indicated herein, in Section 22 00 50, or on the drawings. Hangers shall be placed within one foot of each horizontal elbow.
- C. Vertical runs of pipe and conduit not over 15 feet long shall be supported by hangers placed not over one foot from the elbows on the connecting horizontal runs. Vertical runs of pipe and conduit over 15 feet long but not over 60 feet long and not over 6 inches in size shall be supported on heavy steel clamps. Clamps shall be bolted tightly around the pipes and conduits and shall rest securely on the building structure without blocking.
- D. Hangers shall be of manufacturers hereinafter specified in Section 22 00 50. Unless otherwise specified, pipe and conduit hangers and hanger supports shall conform with the following Anvil International figures:
1. Hangers generally shall be Fig. 69, 104, 212, 260 and 300.
 2. Hangers Figs. 295 and 212 shall be provided with turnbuckles and eye rods or rods with eye nuts.
 3. Turnbuckles shall be Fig. 230 and 114, shall have not less than 1-1/2 inch adjustment, and shall be provided with lockouts.
 4. Clamps shall be Fig. 261 or CT-121.
 5. Wherever the movement of pipe due to expansion exceeds 3/4 inch per foot of hanger rod length, hangers shall be Figs. 171, 174 and 181.
 6. Roller supports shall be adjustable.
 7. Concrete inserts shall be Fig. 282 or 281.

- E. On copper pipes, hangers in contact with pipe shall be copper plated.
- F. In lieu of individual hangers, multiple (trapeze) hangers may be used for water pipes having same elevation and slope and for electrical conduits as specified hereinafter:
 - 1. Horizontal members shall consist of 1-1/2 inch by 1-1/2 inch No. 12 gauge, cold formed electro-galvanized dipped channels designed to accept special springheld hardened steel nuts for securing hanger rods and other attachments. Provide metal framing system with applicable fasteners, brackets, fittings, clamps, etc. Two or more such channels may be welded together forming horizontal members of greater strength than single channels. Members shall be Kindorf Series B-995, Unistrut, or approved equal.
 - 2. Each multiple hanger shall be designed to support a load equal to the sum of the weights of the pipes and liquid. The weight of the hanger rods shall be such that the stress at the root of the thread will not be over 10,000 psi at design load, except that no rod shall be smaller than 3/8 inch. The size of the horizontal members shall be such that the maximum stress will not be over 15,000 psi at design load.
 - 3. Horizontal runs of piping along walls, 4 inch and smaller, exposed or concealed, shall be secured to metal framing system as specified herein. Provide appropriate clamps, brackets and similar attachments to secure piping to vertical members in accordance with applicable sections of the specification.
 - 4. On copper pipes in contact with horizontal member, provide rubber strip (Vibra Strip or equal) between hanger attachment and copper pipe.
- G. Hanger attachments shall be suitable for each type of hanger and shall be compatible with the building material to which it is secured. Under no circumstances shall pipe support be secured to any other mechanical, electrical or fire protection equipment. Support shall be suspended from building structure only. The type of attachments which shall be used for the various types of building construction encountered are as follows:
 - 1. Steel beams - Fig. 226, or 66 attachments.
 - 2. Bar joists - Fig. 225, or 60.
 - 3. Brick or block walls - Fig. 194, 195, 199 or 202 fastened as follows: For light duty, self-drilling anchors in brick and toggle bolts in block; for heavy duty, through bolts with backing plates.
 - 4. Concrete (New) - Inserts, Fig. 281 or 282. Power driver fasteners may be used for light loading as hereinafter specified.
- H. Welded attachments for securing hangers to piping or to structural steel may be provided in lieu of other attachments specified if prior approval is obtained in the field from the Architect. Welded attachments shall be designed so that the fiber stress at any point in the weld or attachment will not exceed the fiber stress in the hanger rod. Generally, welding shall not be permitted in finished spaces.
- I. On insulated piping at hangers, provide calcium silicate inserts and shields at each point of support, see Section 22 00 50 and Section 22 07 00.
- J. In no case shall wire or perforated strap be used for pipe or conduit support.

- K. Secure all hangers for piping and ductwork to joist and beams. In no case shall supports be secured to underside of metal or wood deck unless otherwise directed in the field by the Architect. Contractor shall submit details of method of attachments for approval to the Architect.
- L. Refer to Section 22 00 50 for vibration hanger requirements.
- M. Rooftop supports shall require no roof penetrations, flashing, or damage to the roofing material. The supports shall have a continuous bottom surface to provide even load distribution and minimize point loading of the roof membrane. Base shall be UV resistant recycled rubber. All structural steel components shall be hot-dipped galvanized. Supports shall have a steel channel attached on the top which can accommodate pipe clamps. The supports may accommodate one or multiple pipes racked together. The supports shall be DURA BLOK by Cooper B-Line, or equal by Mifab, Pentair, or Erico.

2.3 SLEEVES AND PLATES

- A. Pipe sleeves through concrete and masonry construction shall be Schedule 40 galvanized steel pipes unless otherwise indicated on the drawings. Openings that cannot be sleeved before slab or wall is poured shall be core drilled. Pipe sleeves through drywall and similar construction shall be sized to pass both pipe and insulation.
- B. Sleeves in existing concrete or masonry walls shall be set and secured with mortar grout and fast drying bitumastic sealant. Caulk the annular space of pipe sleeves with an elastic caulk compound to make installation air and watertight.
- C. Escutcheon plates shall be provided for all exposed pipes and conduits passing through walls, floors, and ceilings in finished areas. Plates shall be chrome plated brass of the split ring type, of size to match the pipe or insulation where installed. Where plates are provided for pipes passing through sleeves which extend above the floor surface, provide deep recessed plates to conceal the pipe sleeves.
- D. Utilize U.L. approved resilient sealant for all penetration seals. Submit method of sealing for approval.
- E. Where watertight sleeves are indicated or required to suit the installation, provide Link Seal rubber seals, as manufactured by Thunderline Corporation, between pipes and sleeves

2.4 MOTORS

- A. Provide motors of a size adequate to drive the equipment but in no case less than the size shown or specified. If a motor larger than that specified is required, the Contractor shall bear the expense of changes in foundations, support, wire and conduit connections, circuit protective devices, variable frequency drives, or other affected elements of the system. Each motor shall have sufficient capacity to start and operate the machine it drives without exceeding the motor nameplate rating at the speed specified or at the load which may be obtained by the drive actually provided. Motors shall be rated for continuous duty at 115 percent of rated capacity; base temperature rise on an ambient temperature of 40°C.

- B. Motors for use with variable frequency controllers shall be "Inverter Ready", suitable for variable speed / variable torque applications, designed to withstand a rise time of 0.10 microseconds and a peak voltage of 1600 per NEMA MG1 Section 31.4.0.4.2.
- C. Motors 1/2 hp and larger shall be 3 phase, Class B, general purpose, squirrel cage, open type, high efficiency, induction motors, unless otherwise specified. Motors smaller than 1/2 hp shall be single phase, open capacitor type in accordance with NEMA standards wound for 115 volts, 60 Hertz, alternating current. Motors 1/6 hp and under may be split phase type.
- D. Motor efficiencies shall comply with the United States Energy and Independence and Security Act (EISA) of 2007 and the latest revision of NEMA Standard MG1 Table 12-2.
- E. Unless otherwise indicated each motor (5 HP or larger) or motor driven equipment (5 HP or larger) shall have a composite power factor (PF) rating of a minimum of 90% when the motor is operating at the design duty defined on the drawings. Power factor correction devices shall be provided to meet the stated criteria.
- F. Devices (such as: capacitors) or equipment (such as: solid state power factor controllers) when required for power factor correction shall be provided with the motors or item or motor driven equipment. The device shall be mounted and wired to the motor by the project electrical contractor.
- G. For a motor or motor driven equipment requiring other than across-the-line starting PF correcting capacitors (or other equipment) shall be connected to motor terminals via a contactor (controller) with a 120 VAC coil. The 120 VAC coil shall be energized via an auxiliary contact on the contactor (controller) used to establish the "run" operating mode for the motor or motor driven equipment.
- H. All motors shall have a warranty period of 5 years from date of substantial completion.

2.5 DRIVES FOR MACHINERY

- A. Equip each motor driven machine with a V-belt drive except those which are directly connected. Where factory designed and assembled belt drives which do not conform to the following are proposed to be furnished, such non-conformity must be noted on the submittals and such non-conformity may be cause for rejection of the item.
- B. Select each drive according to the rating and recommendation of the manufacturer for the service with which used, giving proper allowance for sheave diameter, center distance, and arc of contact less than 180 degrees.
- C. Belts shall be constructed of endless reinforced cords of long staple Aramit, nylon, rayon, or other suitable textile fibers imbedded in rubber. Use belt with correct cross section to fit properly in the sheave grooves. Carefully match belts for each drive.
- D. Motor sheaves less than 20 HP shall be adjustable pitch type so selected that the required rotation speed will be obtained with the motor sheave set approximately in mid-position and have the specified pitch diameter in that position. Motors above 20 HP shall be provided with fixed sheaves to achieve the rated capacity of the fan.

During the Commissioning Phase, if required to meet actual system requirements, a second set of sheaves and belts shall be provided and installed.

- E. Select the motor of a capacity needed to operate the equipment at the specified mid-position operating condition. Where non-overloading motors are specified, select the motor sheave. In no case shall motors be a smaller size than those shown.
- F. Construct sheave of cast iron or steel, bored to fit properly on the shafts and secured with key ways (not set screws) or proper size, except key ways may be omitted for sheaves having 1/2-inch or smaller bores where set screws may be used.
- G. Provide OSHA approved guards for all belt drives. Submit shop drawings for approval.

2.6 DRIP PANS

- A. Where possible to run piping elsewhere, do not run piping directly above electrical (or electronic) work which is sensitive to moisture; otherwise provide drip pans under piping, sufficient to protect electrical work from leakage. Locate pan immediately below piping, and extend a minimum of 6" on each side of piping and lengthwise 12" beyond equipment protected. Fabricate pans 2" deep of reinforced metal with rolled edges and soldered or welded seams; 16 gauge steel with 2 oz. zinc finish hot dipped after fabrication. Provide 3/4" copper drainage piping, properly discharged, to nearest floor drain, service sink, or as directed in the field.

PART 3 - EXECUTION

3.1 WORKMANSHIP:

- A. Each subcontractor shall furnish the services of an experienced superintendent who shall be constantly in charge of the installation of the work.
- B. The quality of workmanship required for each trade in the execution of its work shall be the finest and highest obtainable in that trade working with the materials specified. Workmanship shall be satisfactory to the Architect and his decision as to acceptable quality if final.
- C. Contractor shall provide and execute a Quality Control Plan in accordance with section 01 40 00 Quality Requirements.

3.2 EQUIPMENT CONNECTIONS

- A. All equipment shall be installed and connected in accordance with the best engineering practice and in accordance with manufacturer's instructions and recommendations. Auxiliary piping, valves, and electric connections recommended by the manufacturer or required for proper operation shall be provided.

3.3 COMMISSIONING RESPONSIBILITIES

- A. The Contractor, and all the sub-contractors and suppliers within Division 22, shall cooperate with the commissioning agency (CA), and other commissioning team members, to facilitate the successful completion of the commissioning process.

- B. The contractor shall assign a representative to the commissioning team, and submit the person's name to the commissioning agency, within one (1) month of the award of the contract. The representative shall have the authority to make decisions on behalf of the mechanical contractor as they relate to the organization and scheduling of plumbing commissioning. The representative shall ensure communications between Division 22 contractors and suppliers and all other commissioning team members, and shall foster the necessary cooperative action. One specific responsibility shall be to attend commissioning meetings, and ensure action items arising from them are attended to as required to allow the commissioning process to proceed on schedule.
- C. The Contractor, and all sub-contractors and suppliers, shall cooperate with the Commissioning Agency in carrying out the plumbing commissioning process. In this context, the Contractor shall:
1. Each contractor and sub-contractor in this division shall include in their quotes the cost of participating in the commissioning process as specified herein.
 2. Ensure the automatic temperature controls (ATC) contractor performs plumbing commissioning responsibilities as listed in 23 08 00.
 3. Provide instruction and demonstrations for the Owner's designated operating staff, in conjunction with the commissioning agency and mechanical engineer, and with the participation of qualified technicians from major equipment suppliers and the controls contractor.
 4. Include requirements for submittal data, O&M data, and training information in each purchase order or sub-contract written.
 5. Ensure cooperation and participation of specialty sub-contractors.
 6. Ensure participation of major equipment manufacturing in appropriate start-up, testing and training activities.
 7. Attend commissioning meetings scheduled by the CA.
 8. Notify the CA a minimum of two weeks in advance of scheduled equipment and system start-ups, so that the CA may witness system verifications, and equipment and system startups.
 9. Provide sufficient personnel to assist the CA as required during system verification and functional performance testing.
 10. Prior to startup, inspect, check and confirm the correct and complete installation of all equipment and systems for which system verification checklists are included in the commissioning plan. Document the results of all inspections and checks on the checklists and sign them. If deficient or incomplete work is discovered, ensure corrective action is taken and re-check until the results are satisfactory and the system is ready for safe startup.
 11. Notify the CA a minimum of two weeks in advance, of the time for start of the TAB work. Attend the initial TAB meeting for review of the TAB procedures.
 12. Provide equipment and systems startup resources as specified and required. If during an attempted equipment or system startup, deficient or incomplete work is discovered that would preclude safe operation, the startup shall be aborted until corrective action has been taken. Ensure such action is taken and verified before re-scheduling a new startup. Those responsible for deficient or incomplete work will be responsible for the costs associated with rescheduling.
 13. Carry out performance checks to ensure that all equipment and systems are fully functional and ready for the CA to witness formal functional performance tests (FPTs).

14. Operate equipment and systems for FPTs in accordance with the commissioning plan and as directed by the commissioning agency. If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered, the FPTs will be stopped by the CA. Those responsible for deficient or incomplete work will be responsible for costs associated with rescheduling. Ensure that all corrections necessary for full and complete system operation as specified are completed; then with the ATC contractor and other applicable sub-contractors, carry out functional performance checks to confirm correct operation before applying to the CA to reschedule the FPTs for the system in question.
15. Prepare preliminary schedule for plumbing system orientation and inspections, O&M manual submission, training sessions, pipe system testing, flushing and cleaning, equipment startup, TAB, and task completion for use by the CA. Update schedule as appropriate throughout the construction period.
16. Attend initial O&M staff training session.
17. Conduct plumbing system orientation and inspection at the equipment placement completion stage.
18. Update drawings to as-built condition and review with the CA.
19. Prepare O&M manuals as specified herein.
20. Participate in the O&M staff training sessions with vendors and contractors.
21. Provide written notification to the general contractor or construction manager and CA that the following work has been completed in accordance with the contract documents and the equipment, systems and sub-systems are operating as required.
 - a. Plumbing equipment including all domestic water heaters, fixtures, etc.
 - b. Pumping systems.
 - c. Fire stopping in the fire rated construction, caulking, gasketing and sealing of smoke barriers.
 - d. That the building control system is functioning to control plumbing equipment as specified.
22. Provide a complete set of as-built drawings and O&M manuals to the CA for review.
23. Integrate installation and programming scheduling with construction and commissioning schedules.
24. Inspect, check and confirm the correct installation and operation of input and output field points and devices through documented and signed off point-to-point checkouts.
25. Provide thorough training to operating personnel on hardware operations and programming, and the application program for the system, in accordance with the O&M staff training program in the commissioning plan.
26. In conjunction with the contractor, demonstrate system performance to the CA including all modes of system operation (e.g., emergency) during the functional performance tests (FPTs). If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered, the FPTs will be stopped by the CA. Those responsible for deficient or incomplete work will be responsible for rescheduling costs.
27. Provide control system technician to assist during system verification and functional performance testing.
28. Provide support and coordination with TAB contractor on all interfaces between controls and TAB scopes of work. Provide, at no additional cost to the TAB and

commissioning agencies, all devices, such as portable operator's terminals and all software for the TAB agency to use in completing TAB procedures.

3.4 WATERPROOFING

- A. Under no circumstances shall waterproofing be damaged or penetrated. Should conditions arise which indicate such necessity, notify the Architect.

3.5 CUTTING AND PATCHING

- A. Cutting and patching associated with the work in the existing structure shall be performed in a neat and workmanlike manner. Existing surfaces which are damaged by the Contractor shall be repaired or provided with new materials and methods similar to existing adjacent work, subject to approval of the Architect. Structural members shall not be cut or penetrated unless otherwise indicated on the drawings. Verify in the field with the Architect. Holes cut through concrete and/or masonry to accommodate new work shall be cut by reciprocating or rotary non-percussive methods. Existing masonry block walls shall be patched with new masonry or gypsum board attached and sealed to both block faces.

3.6 SURVEYS AND MEASUREMENTS

- A. Base all measurements (both horizontal and vertical) from established benchmarks. All work shall agree with these established lines and levels. Verify all measurements at site and check correctness of same as related to the work. Verify locations of existing utilities and inverts of same prior to the start of any systems shown connecting to utilities.
- B. Should the Contractor discover any discrepancy between actual measurements or conditions and those indicated which prevent following good practice or the intent of the drawings and specifications, he shall notify the Architect and shall not proceed with his work until he has received instruction from the Architect.

3.7 WELDING

- A. Welding shall conform to current standards and recommendations of the National Certified Pipe Welding Bureau, with all Delaware Occupational Safety and Health Acts, State, County and City Fire Prevention Code Requirements, Fire and Safety Regulations, and NFPA Standard 241 including provision of appropriate portable fire extinguisher.
- B. Before assigning any welders to work covered by this specification, the Contractor shall provide the Architect with the names of pipe welders to be employed for the work, together with each welder's assigned number, letter, or symbol which shall be used to identify the work of that welder and which shall be affixed immediately upon completion of the work, copies of each welder's certified qualification tests prescribed by the National Certified Welding Bureau or by other reputable testing laboratory using procedures covered in the American Society of Mechanical Engineers Building Construction Code, Section IX, "Qualification Standard for Welding and Brazing Procedures Welders, Brazers and Welding and Brazing Operators." Welders must be certified for all positions.

- C. If requested by the Architect, the Contractor shall submit identifying stenciled test coupons made by any operator in question. The Contractor shall require any welder to retake the tests when, in the opinion of the Architect, the work of the welder creates a reasonable doubt as to his proficiency. Tests, when required, shall be conducted at no additional expense to the Owner; and the welder in question shall not be permitted to work as a welder on this project until he has been recertified. Recertification of the welder shall be made to the Architect only after the welder has taken and passed the required test; welder must pass the test without benefit or retests in order to resume work as a welder on the project.
- D. Welding for pressurization piping systems shall conform to American National Standards Institute (ANSI) American Society of Mechanical Engineers (ASME) B31.9, "Code for Pressure Piping, Building Services Piping". The Contractor shall be responsible for the quality of welding and shall repair or replace any work not in accordance with these specifications. Contractor shall, without cost to the Owner, check welds by radiograph, ultrasonic testing, sectioning or a combination of these methods wherever there is a question raised by the Architect as to the quality of a weld; examination of the questionable weld shall be in addition to other system tests specified. Welds shall have penetration complete to the inside diameter of the pipe and the recommended spacing and bevels between ends of pipe prior to welding shall be used in all cases to assure full penetration.

3.8 HANDLING AND STORAGE OF MATERIALS

- A. Proper and suitable tools, equipment and appliances for the safe and convenient handling and placing of all materials and equipment shall be used. During loading, unloading, and placing, care shall be taken in handling the equipment and materials so that no equipment or materials, including Owner furnished, are damaged.
- B. All plumbing equipment delivered to the job site shall be stored under roof or other approved covering, on pedestals above the ground. All enclosures for equipment shall be weatherproof. Any motors which are not totally enclosed, that are involved in the work, shall be stored in a heated area with a minimum temperature of 50 degrees Fahrenheit. All valves shall be stored under roof on wood pedestals above ground. All insulation shall be stored under roof or in trailers, adequately protected from the weather. The Contractor shall follow all written instructions and recommendations of the manufacturer and all requirements of the Architect in oiling, protection and maintenance of equipment during storage. It shall be the Contractor's complete responsibility for the storage and care of the equipment and materials.
- C. If any materials and/or equipment are found to be in poor condition at the time of being installed, the Architect may, at his discretion, order the Contractor to furnish and install new equipment at no cost to the Owner.

3.9 COOPERATION WITH OTHER TRADES

- A. Exact location of fixtures, clean outs, access ports, piping and valves shall be coordinated with all other trades so that there will be no interference between lighting fixtures, piping, ducts, and conduits. Where conflicts between the trades result, they shall be resolved by the Contractor to the Architect's satisfaction and at no expense to the Owner.

- B. Plumbing trades shall give full cooperation to other trades and shall furnish in writing, with copies to the Architect, all information necessary to permit the work of all trades to be installed satisfactorily and with the least possible interference or delay. Exact location of all plumbing equipment in finished spaces shall be coordinated with shop drawings and with elevations indicated on the architectural drawings.

3.10 CLEANING AND PAINTING

- A. Thoroughly clean all exposed surfaces of equipment and material and leave in a neat, clean condition ready for painting. Restore and touch-up factory finishes which have been damaged during construction. Finished painting will be performed under another Division.
- B. Miscellaneous requirements include:
 - 1. Provide complete new finish if, in the opinion of the Architect, the factory finishes are severely damaged.
 - 2. Touch up threads of zinc coated screwed pipe with Rustoleum primer and one coat of enamel conforming to painting specification.
 - 3. All exposed hangers, steel supports and miscellaneous components, and cast iron pipe hangers shall be field painted with Rustoleum primer and one coat of enamel conforming to painting specification.
 - 4. All steel support and miscellaneous components shall be painted with Rustoleum primer and one coat of enamel conforming to the painting specification.

3.11 ACCESSIBILITY:

- A. Locate all equipment which must be serviced, operated or maintained, in fully accessible positions including control valves, balancing valves and isolation valves. Where required and where directed, provide 14 gauge steel access panels, Milcor or equal, to suit material in which installed. Doors installed in fire rated walls or shafts shall be labeled and shall match rating of the construction. Door shall be of sufficient size to allow access to all components, except minimum size shall be 24" x 24", unless otherwise noted.
- B. Equipment deemed inaccessible by the Architect shall be reworked by the Contractor at no expense to the Owner. All doors shall have cylinder locks operable from same key. Submit shop drawings for approval.

3.12 EQUIPMENT BASES SUPPORTS

- A. Under this Division provide all equipment supports required for the plumbing work.
- B. Provide structural members and related materials, inertia pads, platforms, and gratings.
- C. All concrete bases, curbs, and supports shall be furnished under this Division unless otherwise indicated.
- D. The Contractor shall furnish all required foundation sizes, bolts, washers, sleeves, plates and templates for equipment.

- E. The size of the foundation bolts shall be as recommended by the manufacturer.
- F. The type and size of the supporting channels and supplementary steel shall be determined by the Contractor and shall be of sufficient strength and size to allow only a minimum, deflection in conformance with manufacturer's requirements for loading. Contractor shall submit details for approval to the Architect.

3.13 EXCAVATION AND BACKFILL

A. Excavation:

1. Trenches shall be excavated to the necessary width and depth as shown on the drawings. The trench subgrade shall be such as to allow the bedding of the utility with a uniform and continuous bearing on solid, undisturbed earth for the full length of each pipe, except for that portion at the bell ends. The subgrade shall be graded with sufficient accuracy to assure this minimum. The bottom portion of all trenches from the subgrade to a point two feet (2') above the crown or top of the utility shall be as nearly vertical as practicable and at the minimum width.
2. Trenches in fill areas shall not be excavated until embankment construction has been completed to a point at least two feet (2') above the crown or top of the utility being placed.
3. Any part of the bottom of the trench excavated below the specified subgrade shall be back filled, at the Contractor's expense, with bedding materials as hereinafter specified. Whenever wet, or otherwise unstable, subgrade is encountered below the elevation of the original ground surface which existed prior to the time of construction, such soil shall be removed to the depth and extent directed by the Architect and the trench backfilled to the proper grade with bedding material as hereinafter specified. Reimbursement for extra work performed by the Contractor shall be in accordance with General Conditions. Whenever the Architect requires the removal of wet or otherwise unstable subgrade from the fill material previously placed by the Contractor, the cost of all removal of unstable soil, together with backfilling of the trench as herein specified shall be borne by the Contractor.
4. Excavation for manholes and similar structures shall be of sufficient size to leave a minimum of twelve inches (12") and a maximum of twenty four inches (24") clearance on all sides. Any over-depth excavation shall be filled with concrete as directed and at the expense of the Contractor.
5. Provide shoring and sheet piling necessary for excavation and for the safety of personnel and property as directed. Unless otherwise directed, the sides of all excavations over four feet (4') deep must be braced. All shoring, bracing, sheet piling, etc., must be solidly installed heavy timber suitable for the purpose. No lumber shall be buried when excavations are backfilled, except by authority of the Architect.

B. Backfill:

1. No backfill and/or bedding and backfill shall be placed until the construction adjacent or the utility to be backfilled has been inspected, tested and approved. Notify the Architect when inspections are required.

2. Backfill material shall be earth materials only, free from perceptible amounts of wood, debris, or topsoil and shall not contain marble or other elements which tend to keep it in a plastic state. The material shall be free of frost at the time of placement. Backfill for plastic pipes shall be clean sand, free of foreign materials.
3. Bedding materials, for use where trench subgrade is excavated below specified depth or for use at Contractor's option, shall be crushed stone or gravel, meeting the requirements of a S.R.C. No. 6 aggregate or crusher run S.R.C. CR-6 and shall be free of frost at the time of placing.
4. Work broken or ruptured by improperly placed backfill shall be removed and replaced by the Contractor at no additional cost to the Owner.
5. Following inspection as specified above, approved backfill material shall be deposited in the trench with hand shovels, not by means of wheelbarrows, carts, trucks, bulldozers, or similar equipment, in four inch (4") layers and compacted by mechanical tampers until the pipe has a cover of not less than two feet (2'). The remainder of the backfill material shall then be deposited in the trench in eight inch (8") layers and compacted. Any trenches improperly backfilled shall be reopened, then refilled and compacted to the required grade and smoothed off. Backfill shall be placed and tamped to achieve ninety five percent (95%) (Percent of dry weight) compaction.
6. Field density tests may be required by the Architect in areas where, in his opinion, a question exists with respect to compliance with compaction requirements. These tests will be paid for at standard rates by the Owner, where the test results indicate compliance with the compaction requirements, and by the Contractor where the test results indicate non-compliance with compaction requirements. Density tests shall be performed by the methods specified in A.A.S.H.O. Designation T-147, the Field Determination of Density of Soil-In-Place.

3.14 SLEEVES AND PLATES

- A. Sleeves shall be provided by the trade installing the pipe or duct. The sleeves shall be carefully located in advance of the construction of walls and floors where new construction is involved. Provide all cutting and patching necessary to set sleeves which are not placed prior to construction. All cutting and patching necessary to set sleeves which are not placed prior to construction shall be the responsibility of the trade providing the sleeves.
- B. Sleeves shall be provided for all piping and ductwork passing through concrete, masonry, plaster and gypsum wallboard construction. Caulk the annular space of pipe sleeves with an elastic caulking compound to make installation air and watertight.
- C. Fasten sleeves securely in the construction so that they will not become displaced when concrete is poured or when other construction is built around them. Take precautions to prevent concrete, plaster or other materials being forced into space between pipe and sleeve during construction.
- D. Sleeves required in existing concrete or masonry walls shall be set and secured with mortar grout and fast drying bitumastic sealant.

- E. At all sleeves where objectionable noise can be transmitted (e.g. Mechanical and Electrical Rooms), at smoke barriers, at walls above ceilings that extend to the underside of the structure of the floor above, or at fire rated separations, seal all openings between pipes and corresponding sleeves to prevent sound transmission and to maintain fire rating. Use U.L. approved resilient sealant for penetration seals.
- F. Where pipe motion due to expansion and contraction will occur, provide sleeves of sufficient diameter to permit free movement of pipe. Where sleeves pass insulated pipes, the sleeves shall be large enough to pass the pipe and the insulation. Check construction to determine proper length for various locations; make actual lengths to suit the following:
 - 1. Terminate sleeves flush with walls, partitions and ceilings.
 - 2. Terminate sleeves 2 inches above finished floor in equipment rooms, kitchen and wet floor areas.
 - 3. In all other areas, terminate sleeves 1/2 inch above finished floor unless otherwise noted on the drawings or directed in the field.

3.15 FLASHING

- A. Openings for pipes through waterproofed floors and roof areas shall be flashed. Vent pipes shall be flashed with 4 lb. sheet lead 24 inches square. Flashing shall be extended up around vents, which shall terminate not less than 12 inches above roof, and shall be fastened under vent caps.
- B. Refer to Architectural drawings and specification for additional roof flashing requirements.

3.16 COORDINATED DRAWINGS

- A. Prior to installation of plumbing work in all areas of the building including exposed areas (spaces without ceilings); the Contractor shall prepare completely coordinated layout drawings indicating the coordinated work of all trades involved. The drawings shall be a sheet size similar to the contract drawings. All work shall be to scale minimum $\frac{1}{4}" = 1' - 0"$. The drawings shall include all work shown on the drawings, including equipment (chillers, boilers, air handling units, pumps, water heaters, storage tanks, steam generators, converters, etc.), variable frequency controllers, ATC control panels, terminal units, ductwork, air devices, dampers, piping including sprinkler and plumbing, valves, light fixtures, electrical cable trays, raceways and conduits 2" and larger.
- B. All trades shall be responsible for the preparation of the coordinated layout drawings. Each trade shall provide written certification that the coordinated drawings have accurately incorporated their work and that all conflicts are resolved or a solution is proposed on the drawings. The Contractor shall schedule the trades accordingly and shall provide final certification that all coordination has been completed.
- C. No work shall be installed prior to the Architect's approval of the drawings. The Contractor shall submit for approval of the Architect within 15 days after the award of the contract a schedule of proposed building areas to be grouped for coordination.

Upon approval of the schedule, work may commence in areas of the building upon approval of that area's coordinated drawings prior to approval of another area.

3.17 CLOSE OUT PROCEDURES

- A. Refer to Section 01 77 00 Close Out Procedures for specific requirements.

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SECTION 22 00 50

PLUMBING BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This section includes requirements for plumbing equipment, materials and procedures which are common to more than one section of Division 22 and which are general in nature and use. This section applies to all sections of Division 22.
- B. The requirements of Section 22 00 10, Plumbing General Provisions, shall apply to all work specified under this section.

1.3 LEAD CONTENT

- A. All plumbing products, materials of construction, and joining methods used in the installation or repair of plumbing intended to dispense water for human consumption shall be in compliance with the United States Safe Drinking Water Act and shall meet the limit of weighted average lead content as set forth in NSF/ANSI 372. All such products shall also meet the lead leaching requirements of NSF/ANSI 372.
- B. All products used for domestic water shall also meet the California AB1953, which specifies that solder does not contain more than 0.2% lead, and flux not more than a weighted average of 0.25% lead for wetted surfaces. This requirement is for compliance with the LEED credit for Innovation: PBT source reduction – lead, cadmium and copper.

1.4 SUBMITTALS

- A. Submit shop drawings for all items of materials specified in this section in accordance with Section 22 00 10.
- B. At a minimum Manufacturer's product data shall include specifications, installation instructions and general recommendations for each type of material required. Include data substantiating that proposed materials comply with specified requirements for each type.

1.5 TESTS AND ADJUSTMENTS

- A. The Contractor shall furnish labor, instruments, equipment, and materials required to perform tests prescribed in the sections describing the various systems.

- B. Replace or repair defects found during inspection or test with new materials. Caulking of welded joints, screwed joints, cracks, or holes is not acceptable. Correct leaks in screwed fittings by remaking joints. In welded systems leaks in joints shall be cutout and re-welded. Repeat tests after defects have been eliminated.
- C. Where reasonable doubt exists as to a system's ability to comply with contract requirements, perform any reasonable test required by the Architect.
- D. Make static pressure tests and prove to the satisfaction of the Architect that the piping is tight before pipes are concealed or insulated. Tests shall be provided as hereinafter specified.
- E. Use test instruments for accuracy by an approved laboratory or by the instrument manufacturer and furnish certificates showing degree of accuracy to the Architect when requested. Make calibration histories for each instrument available for examination.
- F. Where gauges, thermometers and other instruments which are to be left permanently installed are used for tests, do not install until just prior to the tests to avoid possible changes in calibration.

PART 2 - PRODUCTS

2.1 HANGERS

- A. Refer to Section 22 00 10.
- B. Hangers and accessories shall be Anvil International, Fee and Mason, Modern, National, or B-Line of the types specified in Section 22 00 10.
- C. It shall be the responsibility of the Contractor to provide an adequate pipe suspension system in accordance with recognized engineering practices, using standard, commercially accepted pipe hangers and suspension equipment.
- D. The design of all hangers and support shall be in accordance with the provision of the current issue of MSS-SP-58 document developed as a standard by the Manufacturers' Standardization Society.
- E. Hangers for steel pipe, except as noted otherwise shall be spaced at least every ten (10') feet. Hangers for cast iron pipe shall be provided at each joint. Hangers for copper pipe shall be placed at least every eight (8') feet, except pipes 1¼ inch and smaller and shall have hangers at six (6') foot intervals. Polyvinyl chloride pipe (PVC) shall have hangers at four (4) foot intervals.
- F. Where concentrated loads of valves, fittings and similar items occur, or if recommended by the piping manufacturer, closer hanger spacing will be necessary.
- G. Generally, hangers shall be clevis type, standard weight.
- H. Vibration hangers shall be provided as specified.

- I. On insulated piping systems, provide Pipe Shields, Inc., Model CS-CW or approved equal hanger shields at each point of support. Diameter of hanger shield shall match thickness of the insulation. In lieu of, provide wood dowel insert and minimum twenty-gauge protection shield at each point of support. Diameter of insert and shield shall match thickness of the insulation and encompass 50% of insulation surface. On cold systems seal insert vapor tight with appropriate coating.
- J. Hangers in direct contact with copper piping systems shall be copper plated.

2.2 IDENTIFICATION AND EQUIPMENT TAGS

- A. All control devices, i.e. panels, switches, starters, push button stations, controls etc., shall be clearly identified as to their function and the equipment controlled.
 - B. All plumbing equipment shall be marked to clearly identify said equipment and space or duty they serve.
 - C. Plumbing equipment herein specified shall be identified using engraved laminated black and white phenolic legend plates. Letters shall be minimum, 3/4" high white on surrounding black. Plates shall be mounted by means of sheet metal screws. Submit nameplate list to Architect for approval.
 - D. Plumbing equipment, valves, etc., concealed above ceiling shall be identified as to location using clear plastic self-adhesive tape with black lettering, applied to ceiling tile "T" bars. Submit nameplate list to Architect for approval.
 - E. Piping shall be identified with colored, pre-rolled, semirigid plastic labels as manufactured by Seton, Marking Services, Inc., or approved equal. For indoor installations, labels shall be Seton "Set Mark" system or approved equal. For outdoor installations, labels shall be Seton "Ultra Mark" system or approved equal. Labels shall be set around pipes with a field installed high strength cement around pipes with a field installed high strength cement compound applied along their longitudinal edge. Labels shall be placed around the piping or insulation every forty feet (40) and with one (1) label on each pipe in rooms smaller than fifteen feet (15). A label shall be placed at every major valve and at least six feet (6) from exit or entrance to an item of equipment. At Contractor's option, piping concealed above suspended ceilings only, may be identified by stenciling with black paint and taped color bands in accordance with the coding system herein specified.
- 1. Labels shall be provided in accordance with the following table with color coding and stencil designations as indicated:

SIZE OF LEGEND LETTERS

Outside Diameter of Pipe (Inches)	Length of Color Field (Inches)	Size of Letters (Inches)
3/4" to 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"

8" to 10"	24"	2-1/2"
Over 10"	32"	3-1/2"

2. Color coding and stencil designations shall be as follows:

<u>Service</u>	<u>Color</u>	<u>Stencil Designation</u>
Domestic cold water	Green	Domestic cold water
Domestic hot water	Yellow	Domestic hot water
Domestic hot water recirculating	Yellow	Hot water recirculating
Sanitary	Brown	Sanitary sewer
Storm water	Brown	Storm water
Vent	Brown	Sanitary sewer
Condensate drain	Brown	Drain water

- F. All valves, except as specified below, shall be provided with colored plastic or brass valve tags with stamped-in numbers. Tags shall be secured to valve wheels with metal chain. Stop valves on individual fixtures or equipment where their function is obvious, or where the fixture or equipment is immediately adjacent, need not be so equipped. Care shall be exercised in selecting valve numbers to be prepared on tracing linen showing locations, details of arrangements, etc., of all service and control valves indicating identity and function. One black line print of each drawing shall be mounted under glass where directed. Valve tags shall be Seton or approved equal minimum 1-1/2" round tags with white characters describing system and valve designation. Submit valve number list for approval.

2.3 PIPE, FITTINGS, AND JOINTS

A. General

1. Piping materials shall conform to state and local code requirements. Pressurized piping systems shall conform to American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME) B31.9, "Code for Pressure Piping, Building Services Piping". High-pressure piping shall conform to ANSI/ASME Section I, B31.1, "Code for Pressure Piping, Power Piping".
2. Quality and weight of materials shall comply with requirements of applicable American Society of Testing Materials (ASTM), ANSI, ASME, and Cast Iron Soil Pipe Institute (CISPI) standards. ASTM number and wall thickness shall be indicated on each pipe length
3. Provide pipe and fittings for systems as hereinafter specified. All references to codes shall apply to the latest year. Grooved products may be as manufactured by Victaulic or Grinnell. All piping and fittings shall be made in America. All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer.

4.

B. Pipe Materials

1. Sanitary Drainage

a. Underground

1) Cast Iron Soil Pipe

- a) All sizes - service weight ASTM A74-98, fittings shall be cast iron service weight ASTM A74-98 fitting joints shall be pre-molded rubber gaskets, Tyler Pipe Industries, Ty-Seal Or Multiple Seal, polyvinyl chloride gaskets manufactured in accordance with ASTM C 564.

b. Above ground, within the building

1) No-hub Cast Iron Soil Pipe

- a) All sizes - service weight, ASTM A888-98 fittings shall be no-hub cast iron, fitting joints shall be no-hub neoprene gasket and stainless steel corrugated shield, four band, Anaco-Husky series 4000 meeting ASTM C 1540, C564, and CISPI 310.

2. Vent Piping:

a. No-hub cast iron soil pipe

- a) All sizes - service weight, fittings shall be no-hub cast iron, fitting joints shall be no-hub neoprene gasket and stainless steel corrugated shield, Anaco-Husky series 4000 meeting ASTM C 1540, C564, and CISPI 310.

3. PVS Piping:

a. Galvanized Steel Pipe

- a) 4 inches and smaller – ASTM A53A, ANSI schedule 40, fittings shall be galvanized cast iron screwed type ANSI B16.12, with threaded joints: American Standard for Pipe Threads, ANSI B2.1.

4. Storm Water Drainage

a. Underground

1) Cast iron soil pipe

- a) All sizes - service weight, ASTM A74-98, fitting shall be cast iron service weight ASTM A74-98, fitting joints shall be pre-

molded rubber gaskets, Tyler Pipe Industries, Ty-seal or Multiple Seal, polyvinyl chloride gaskets manufactured in accordance with ASTM-C-564-98.

b. Above ground, within the building

1) No-hub cast iron soil-pipe

- a) All sizes - service weight, fittings shall be no-hub cast iron, fitting joints shall be no-hub neoprene gasket and stainless steel corrugated shield, Anaco-Husky series 4000 meeting ASTM C 1540, C564, and CISPI 310.

5. Foundation Drains

- a. Foundation drainage piping shall be Type S double wall 4" slotted corrugated exterior and smooth interior wall polyethylene (PE) tubing according to ASTM F-405 with maximum 1/8" slot width for at least the lower 120 degree sector with similar fittings.
- b. Foundation piping running beyond the foundation to the storm water connection or manhole can be a solid schedule 40 PVC pipe.
- c. Geotextile requirements are as follows:

Grab strength lbs. (ASTM D4632)	120 lbs. (min.)
Elongation (%) (ASTM 4833)	N/A
Puncture Strength (ASTM 3786)	60 lbs. (min.)
Burst Strength (ASTM 3786)	225 PSI (min.)
Trapezoidal tear (ASTM D-5741)	50 lbs. (min.)
Apparent opening size	<#70 US Standard Sieve Minimum
Permittivity (ASTM D4491)	1.01/sec. (min.)
Ultraviolet degradation at 150 hrs (ASTM D4355)	70% strength retained

6. Air Conditioning Condensate and Equipment Drainage:

a. Copper drainage tubing

- 1) All sizes - DWV, ASTM B306 with wrought copper and bronze drainage fittings, ANSI B16-29 with soldered joints: Taramet Sterling "lead free" solder or equivalent. All solder joints shall comply with

ASTM B828 2002, and shall use ASTM B813 2010 for flux to comply with the LEED Innovation credit: PBT source reduction – lead, cadmium and copper.

7. Domestic Cold Water:

a. Domestic cold water above ground, all sizes

1) Seamless copper water tube

- a) All sizes - ASTM B88, Type L hard tempered with press fittings. Press fittings shall be Viega ProPress or approved equal. Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed or an alternative supplied by fitting manufacturer. Press ends shall have SC (Smart Connect) feature design (leakage path).

8. Domestic Hot Water and Hot Water Recirculation:

a. Seamless copper water tube

- 1) All sizes - ASTM B88, Type L hard tempered with press fittings. Press fittings shall be Viega ProPress or approved equal. Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed or an alternative supplied by fitting manufacturer. Press ends shall have SC (Smart Connect) feature design (leakage path).

2.4 VALVES

A. General

1. Valves shall be provided where indicated on drawings and as herein specified.
2. Valves shall be placed in such a manner as to be easily accessible for handwheel operation and stuffing maintenance.
3. Valves in piping where shown and where listed herein:
 - a. To balance flows in plumbing piping systems.
 - b. To isolate all items of equipment.
 - c. To isolate motorized flow control valves.
 - d. To isolate branch lines and riser at mains.
4. Valve pipe connections shall be screw, solder, welded, flanged, press fit or Victaulic as required to be consistent with other parts of the piping system.
5. Where piping or equipment may subsequently need to be removed, provide valves with bodies having integral flanges or full lugs drilled and tapped to hold

valve in place so that downstream piping or equipment can be disconnected and replaced with blank-off plate while valve is still in service.

6. In mechanical rooms, valves over ten feet above standing level and above 4" in size shall have chain wheel with chain extending to within six feet of standing level. All wheel operated valves shall have an indicator to show the position of the disc or plug.
7. Install valves in accessible locations and adjust for smooth and easy operation.
8. Valves for equipment and controls shall be installed full size of pipe before reducing size to make connection.
9. Where there is no interference, shut-off valves shall be installed with handwheel down on horizontal runs of pipe to prevent accumulation of foreign matter in packer between seats at closing end of wedge.

B. Balancing Valves

1. Provide balancing valves where indicated and required to balance water flow through the piping system. For pipe sizes 2 1/2" and larger provide separate balancing valve and flow meter fitting.
2. Balancing valve for system piping shall be DeZurik, Homestead or approved equal eccentric plug valve as follows: flanged 2-1/2" and larger, with Fluorinated Hydrocarbon filler in a PTFE U-ring (packing) and CIIR or EPDM plugs and Chloro-Isobutene Isoprene plug facing suitable for -20 to 250°F continuous operation. Valves shall have lever actuators with adjustable memory stop. For 2" and smaller, provide combination balancing and flow fitting with screwed ends as manufactured by Nexus, Tour & Anderson, or approved equal.

C. Ball Valves

1. Ball valves shall be used in lieu of gate valves in all domestic water piping systems size 3" and smaller for shut-off service. Ball valves shall be Apollo, Red White Valve Corp, Jomar or approved equal.
2. For valves up to 2½" in size the body and bonnet shall be ASTM B62 bronze. For valves 3" body shall be bronze or brass. Ball shall be Type 316 stainless steel. Stem shall be stainless steel. Seats shall be TFE.
3. Stem shall be blowout proof and externally adjustable to compensate for wear. Valve shall be equipped with vinyl covered lever handle which shall indicate position of ball orifice and shall have stops for fully open and closed position. Construction shall be such that power actuator can be used. Ball opening shall be full pipe size.
4. Valve shall be suitable for flow in either direction and shall be rated 150 psig SWP and 600 psi non-shock WOG.
5. Valve shall be so constructed with two piece cast bronze bodies, full port design, with adjustable stem packing. Valves used for domestic service shall be lead free.
6. Ball valves used for balancing shall have adjustable memory stop. For use in insulated piping systems provide 2" extended handles of non-thermal conductive material.

D. Drain Valves

1. Drain valves shall be ball valves with hose end connections and shall be provided at low points of all piping system and where indicated or required, 3/4" minimum. Provide Nibco Series 585-70-HC or approved equal. Valve shall be rated for 125 lbs.

E. Valve Schedule

1. Unless otherwise specified, valves shall be Grinnell, Stockham, Crane, Jenkins, or Nibco equal to the Nibco figure numbers indicated herein:
2. Domestic Hot and Cold Water Systems:
 - a. Check - Solder end S-413
 - b. Check valves at pump discharge shall be in line spring loaded or swing design with weight or lever and spring.

2.5 PIPE ANCHORS

- A. All pipe lines shall be anchored where specified herein, indicated on drawings and where required to prevent uncontrolled movement. Anchors shall be constructed of steel and plates, assembled by bolting or welding and secured to the building structure by means of clamps or welding. Structural members shall not be cut or drilled. Anchors shall prevent both axial and lateral movement of the lines. Anchor vertical pipes by means of clamps welded to pipe and secured to wall or floor construction. Submit details of anchors to Architect for approval.
- B. Anchor piping adjacent to flexible pipe connectors to prevent connector from expanding against its restraining bolts and also to keep the pipe on both sides of the connector in alignment.

2.6 EXPANSION (WATER SYSTEMS)

- A. Where expansion joints are indicated or required, select joints with a traverse of 150 percent of the pipe expansion from the ambient 40 degrees F to the maximum system operating temperature.
- B. All expansion joints shall be suitable for minimum operating pressure and temperature of 150 psi and 300 degrees F, respectively. Expansion joints 2" and larger shall have flanged ends, except when installed in copper pipe systems.
- C. Submit for approval manufacturer's shop drawings of each expansion joint provided depicting length of pipe, location of anchors and guides, calculated expansion offset and type of joint employed.
- D. Expansion joints shall be as herein specified:
 1. Loop expansion joints
 - a. Provide flexible hose expansion loop(s) as indicated on the contract drawings or as required to accommodate any thermal expansion, contraction or seismic movement of the piping system.

- b. Flexible hose expansion loops shall be manufactured complete with two parallel sections of corrugated metal hose, compatible braid, 180 deg return bend, with inlet and outlet connections. Field fabricated loops shall not be acceptable.
- c. Flexible loops shall be capable of movement in the $\pm X$, $\pm Y$, and $\pm Z$ planes.
- d. Flexible hose expansion loops shall impart no thrust loads to system support, anchors or building structure.
- e. For flammable liquid or gas service up to 4", flexible expansion loops shall be CSA / AGA certified.
- f. All flexible hose expansion loops shall be manufactured in accordance with the documented manufacturers weld procedure specifications. The procedure qualification record shall be used to document the execution of this procedure and shall follow the general "guidelines" of ASME Section IX. Each individual welder shall conform to the in-house procedure qualification record and be qualified prior to each production lot. The testing of each individual welder shall be documented in a welding procedure qualification record.
- g. Flexible hose expansion loops to be Metraloop as manufactured by The Metraflex Company or approved equal.
- h. Corrugated Hose shall be [stainless steel] with 304 stainless steel braid.
- i. Fittings Materials of construction and end fitting type shall be consistent with pipe material and equipment/ pipe connection fittings. Copper fittings shall not be attached to stainless steel hose.
- j. Flexible hose expansion loops shall have a factory supplied, hanger / support lug located at the bottom of the 180 degree return.
- k. Flexible hose expansion loop(s) shall be furnished with a plugged FPT to be used for a drain or air release vent, and hanger lug at the bottom of the 180 degree return.

2.7 PIPE GUIDES

- A. Provide pipe guides where indicated on drawings or where required for proper installation of expansion loop. Limit use of guides with expansion loop to point shown or where required to prevent buckling of pipe whether indicated or not.
- B. Do not use pipe guides as pipe supports.
- C. Provide factory made cast semi-steel or other heavy fabricated steel consisting of bolted two-section outer cylinder and base with a two-section guiding spider welded or bolted tight to the pipe of sufficient size to clear pipe insulation and long enough to prevent over-travel of spider in cylinder. Furnish a guide sleeve of a length not less than the length of pipe expansion plus the spider length.

2.8 VIBRATION ISOLATION

- A. General:
 - 1. Plumbing equipment and associated piping shall be mounted on vibration isolators as specified and required to minimize transmission of vibrations and structure-borne noise to building structure or spaces.

2. Select vibration isolating units for the lowest operating speed of equipment so designed that natural frequency of equipment and base mass is not less than 1.5 times the lowest operating frequency of the moving equipment but not a multiple or harmonic of the base frequency. Furnish vibration isolation producing a uniform loading and deflection even when equipment weight is not evenly distributed, and be stable during starting and stopping of equipment without excessive traverse and eccentric movement of equipment.
3. Concrete pads under the isolation units shall be reinforced. Use concrete having a minimum compressive strength of 2500 psi and structural reinforcing bars conforming at ASTM A-615 Grade 60.
4. The installed vibration isolation system for each floor or ceiling mounted item of equipment shall have a maximum lateral motion under equipment start up and shut down conditions of 1/4". Motions in excess shall be restrained by approved spring type mountings.
5. All electrical connections, drain connections, etc., made to equipment which rests on vibration isolators, shall be sufficiently flexible to permit the equipment to be properly isolated.
6. The type of isolation, base, and minimum static deflection shall be as required for each specific equipment application, but no case less than that specified herein when supported on a solid concrete structural slab having a thickness of not less than 4". If vibration isolators with a deflection greater than the minimum specified are required to meet the noise criteria for the adjacent spaces, suitable isolation systems shall be submitted. Should vibration isolators installed for the equipment prove inadequate to prevent transmission of equipment vibrations to the building structure or limit equipment vibration originated noises in the building spaces to acceptable levels, the isolators shall be replaced with units having the largest deflection that can be practicably installed.
7. Spring and combination rail and spring isolation supports where designated in the schedule are indicated for equipment structurally built or supported on a rigid structural steel frame suitable for these types of isolation. Where these types of isolation are not suitable for the equipment construction or operation, the equipment shall be mounted on a structural steel base as herein specified.
8. Equipment affected by wind pressure or with operating weight different from installed weight shall have built-in adjustable vertical stops to prevent rising of equipment when weight is removed. Equipment containing liquid shall have vertical stops.
9. Inertia bases shall consist of a steel reinforced concrete slab cast into a welded structural steel channel frame. Frame shall be fabricated of sufficient strength to prevent distortion of any type during construction, and when the equipment is in operation. Equipment anchor bolts with bottom plates and pipe sleeves shall be preset. One-half inch steel reinforcing bars shall be placed on 6" center both ways in a layer 1-1/2" above the bottom of the base; bars shall extend inside channel frame flanges not less than 1".
10. Where required due to equipment configuration, the inertia block construction shall change and the concrete thickness shall increase as necessary for the proper mounting of the equipment. The weight of the inertia base shall be equal to or greater than the weight of the equipment supported. Additional weight necessary to reduce vibration or motion caused by the equipment's unbalanced forces to less the 1/32" movement shall be provided when necessary.
11. Concrete sub-bases not less the 4" shall be provided for all floor mounted mechanical equipment under another Division. Sub-bases shall rest on a

- structural floor and shall be reinforced with steel rods and interconnected with floor. A minimum clearance of 2" shall be provided between sub-bases and all inertia blocks, steel bases, and steel saddles with equipment in operation.
12. Each electric motor shall be mounted on the same foundation as the driven machine. Piping connections including strainers at pumps shall be supported on the same foundation as the pumps.
 13. All exterior vibration isolation shall be hot dip galvanized.

B. Vibration Isolation Equipment

1. All isolation equipment shall be Mason Industries, Kinetics Noise Control, Vibration Eliminator, Amber/Booth, or Korfund equal to the following Mason Industries products:
 - a. Type IV Hanger - combination spring and double deflection neoprene element. Mason Type 30N.
 - b. Type V Hanger - similar to Type IV with elevation holding device. Mason Type PC30N.
 - c. Type VII Hose - Flexible pipe connector. Mason Type SFEJ or approved equal, with control rods.

C. Application of Isolation Equipment:

Item	Type	Deflection
Piping – hangers within 50 ft. of isolated equipment	V	1.50"
Piping – First two hangers near non-isolated equipment	IV	0.75"
Flexible Pump Connectors	VII	---

2.9 PRESSURIZED DIAPHRAGM TYPE EXPANSION TANKS

- A. Provide for the domestic water heating systems where indicated on the drawings pressurized diaphragm type expansion tanks as manufactured by Amtrol, Armstrong, B&G, or Taco equal to Taco Series CAP or CAX. Capacities shall be indicated. Submit selection calculations for approval.
- B. Each tank and system shall be air pre-charged to the initial fill pressure of its respective system, suitable for a maximum working pressure of 125 psig and furnished with ASME stamp and certification papers. Tanks shall have replaceable elastomer diaphragm suitable for an operating temperature of 240 degrees F. Provide air charger tank connection.

2.10 TEST PLUGS

- A. Pressure and temperature test plugs where indicated or required shall be 1/4" npt fittings, suitable to receive either a 1/8" OD temperature or pressure probe. Fittings shall be solid brass with Nardel valve core, fitted with a color-coded marked cap with gasket. The entire assembly shall be rated at 1000 psig. Provide two (2) pressure

gauge adapters and two (2) 5" stem thermometers, 0 to 220 degrees F and 20 to 130 degrees F range. Plugs shall be as manufactured by Peterson Equipment Company, Inc., Richardson, Texas or Sisco plugs, or approved equal.

PART 3 - EXECUTION

3.1 CLEANING

- A. After completion of installation, thoroughly clean dirt, rust, loose scale, oils and grease, and other foreign matter from metal and insulated surfaces, painted or unpainted, specified under Division 22 of the specification.
- B. Clean all systems piping thoroughly of grease, metal shavings, welding beads, or other refuse. Flush piping by use of portable pump or separate water supply to prevent damage to existing or new system pumps. Before cleaning closed systems, all equipment shall be isolated by closing inlet and outlet valves and opening the by-pass valves. The system shall be filled with sufficient detergent and dispersant added to remove all dirt, oil, and grease. System shall be circulated for at least 48 hours after which a drain valve at the lowest point shall be opened and allowed to bleed while the system continues to circulate. Bleeding shall continue until water runs clear and all detergent is removed. A sample of the water shall be tested and, if PH exceeds the PH of the make-up water, draining shall be resumed. After flushing, clean strainers of debris, open coils and close by-passes. Remove dirty water filters and install new water filters. Turn over replacement bag filters to Owner. Refill and vent water systems being sure to add water after venting to completely fill system.

3.2 PIPING INSTALLATION

- A. Install piping without undue stress or strain in locations shown and run parallel to the lines of the building, except to grade them as specified in a neat and workmanlike manner using a minimum of fittings. Provide such fittings, valves, and accessories as may be required to meet the conditions of the installation. Contractor shall inform himself fully regarding any peculiarities and limitations of space available for installation of material under each section of specifications. Install piping to suit necessities of clearance with ducts, conduits, structure, and other work, and so as not to interfere with any passages or doorways and allow sufficient head room at all places. Use proper reducing fittings for changing piping sizes.
- B. Do not install piping through transformer vaults, elevator equipment rooms or other electrical or electronic equipment spaces. Do not route piping over electrical-distribution panels.
- C. Cut pipes accurately to measurements established in the field in a neat and workmanlike manner without damage or without forcing or springing. Perform cutting by means of an approved type of mechanical cutter of the wheel type where practicable. Ream pipe after cutting to remove all burrs.
- D. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories which may be required. Carefully investigate the architectural, structural, and existing conditions affecting the work, and arrange such work

accordingly, providing such fittings, and accessories as may be required to meet such conditions.

- E. Install unions and flanges where shown and on each side of all pieces of equipment and other similar items, and in such a manner that the unions or flanges can be readily disconnected. Do not place any union or flange in a location which will be inaccessible after completion of the project. Unions or flanges for servicing and disconnect are not required in installations using grooved joint couplings.
- F. Grooved joints shall be installed in accordance with the manufacturer's latest published instructions. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service. Gaskets shall be molded and produced by the grooved coupling manufacturer. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Contractor shall remove and replace any improperly installed products.
- G. Unions in steel pipe 2-1/2" and smaller for water service, shall be 250 lb. malleable iron brass, seat type. Use 150 lb. forged steel flanges for piping 3" and larger. Gaskets shall be 1/8" thick rated for 150 psi service at 250°F. Unions in copper pipe 2" and smaller shall be wrought copper with red bronze ring nut. Use 150 lb. ASME copper flanges for piping 2-1/2" and larger.
- H. Use dielectric unions or couplings at all junctions of copper or brass piping and fittings with ferrous material to prevent electrolysis and galvanic corrosion. Dielectric fittings shall be a copper-silicon casting conforming to UNS C87850, and UL classified in accordance with ANSI / NSF-61 for potable water service. Fittings shall have threaded ends, grooved ends, or a combination. Grooved end fittings shall be Victaulic Style 647.
- I. Joints between dissimilar piping material shall be made with appropriate adapters in accordance with the respective manufacturer's printed instruction and recommendations.
- J. Use reducing fittings, eccentric where required to prevent pocketing of air and water or both, to make changes in pipe sizes.
- K. Grade pipe minimum 1" in 40 feet to low points, unless otherwise specified or indicated. Provide drain valves at all low points.
- L. Install wells in domestic heating hot water systems for automatic temperature control sensors. Exact locations and number of wells required shall be determined through coordination with the work required under Section "Automatic Temperature Control."
- M. All piping shall be so installed so that it will in no way be distorted or strained by expansion or contraction. Except as noted, all expansion and contraction shall be taken up by means of swing joints, loops, bends or long offsets. Swing joints made up with at least three fittings shall be provided in branches from mains to runouts. Size loops for the total pipe expansion without cold springing, but field cold spring one-half the pipe expansion corrected for ambient temperature.

- N. Provide a fitting restraint system at the base of each no hub storm water piping riser 4" and larger in size, and extending vertically 3 floors or greater, with all base ells 45° to 90°. Fitting restraint system shall be Holdrite No Hub Series 117, or approved equal.
- O. Coat all uninsulated piping underground (except cast or ductile iron piping or polymer) with two layers of asphaltic paint, one layer of six-mil polyethylene film, one layer of 15-pound asphaltic felt. Spirally wrap all pipe lines embedded in concrete with two layers of 30-pound asphaltic felt.
- P. Underground piping shall be installed in a continuous enclosure to protect the pipe from damage during backfilling. The enclosure shall be split or otherwise provide access at the joints during visual inspection and leak testing. Backfill shall be clean and compacted so as to protect and uniformly support the piping. A continuous tape or marker placed immediately above the enclosure shall clearly identify the pipeline by specific name. In addition, a continuous warning means shall be provided above the pipeline at approximately one-half the depth of bury. Where underground piping is installed through a wall sleeve, the ends of sleeve shall be sealed to prevent the entrance of ground water. Piping underground within buildings or embedded in concrete floors or walls shall be installed in a continuous conduit.

3.3 LOOP EXPANSION JOINTS

- A. Install and guide per manufacturer's installation instructions and Mechanical Contractors Association of America "Guidelines for Quality Piping Installations".
- B. Flexible hose expansion loop return fitting shall be supported to allow movement.

3.4 WORKMANSHIP

- A. Cut pipes accurately to measurement established at structure. Install pipes without springing or forcing.
- B. Clear windows, doors, and other openings with all pipes. Arrange pipes to permit expansion and contractions without misalignment or damage.
- C. During construction all openings in piping and equipment shall be closed with caps or plugs to keep out all foreign matter indicated.
- D. All piping in finished spaces shall be run concealed unless otherwise indicated.

3.5 WELDING

- A. Refer to Section 22 00 10.

3.6 SLEEVES AND PLATES

- A. Refer to Section 22 00 10.

3.7 FLOW METER FITTINGS

- A. Locate and arrange piping, both upstream and downstream of fitting to conform to the manufacturer's published literature.

- B. When flow is measured in horizontal pipe, locate the connection nipples at or slightly above the horizontal centerline of the pipe to minimize the entrance of gases and impurities.
- C. Provide each fitting with an integral tab, or a metal tag or a stainless steel wire, extending outside the pipe covering, and stamp or print in a plainly visible position the manufacturer's name and address; the model number of the meter to which it is to be connected; the name, number or location of the equipment served; the specified rate of flow and the multiplier (including unity, where applicable) to be applied to the meter reading.
- D. Provide fittings with shut-off valves and with quick connecting hose fittings for portable meters.

3.8 TESTS

- A. The following tests shall be conducted by the Contractor and all piping shall be proven tight in the presence of the Architect or his representative. Notify Architect prior to tests. These tests shall be conducted before any insulation is installed and any insulation installed prior to test shall be removed. Provide all equipment and labor required. Tests shall be at least four hours in duration. Piping may be tested in sections as approved by the Architect. Tests shall be specified herein.
- B. Domestic water piping shall be hydrostatically tested to 150 psig. All openings in the water piping shall be plugged throughout the system, or portion thereof, filled with water, and tested with a pump to a pressure of 150 psig.
- C. Sterilization
 - 1. Domestic water system piping shall be disinfected after tests in accordance with State or District Health Department requirements. Before placing the systems in service, contractor shall engage a qualified service organization to sterilize the new water lines in accordance with the following procedure:
 - 2. Through a 3/4" hose connection in the main entering the building, pump in sufficient sodium hypochlorite to produce a free available chlorine residual of not less than 200 PPM. Plumbing contractor shall provide plumbing connections and power for pumping chlorine into the system.
 - 3. Proceed upstream from the point of chlorine application opening all faucets and taps until chlorine is detected. Close faucets and taps when chlorine is evident.
 - 4. When chlorinated water has been brought to every faucet and tap with a minimum concentration of 200 PPM chlorine, retain this water in the system for three (3) hours. CAUTION: Over-concentration of chlorine and more than three (3) hours of retention may result in damage to piping system.
 - 5. At the end of the retention period, no less than 100 PPM of chlorine shall be present at the extreme end of the system.
 - 6. Proceed to open all faucets and taps and thoroughly flush all new lines until the chlorine residual in the water is less than 1.0 PPM.
 - 7. Obtain representative water sample from the system for analysis by a recognized bacteriological laboratory.

8. If the sample tested for coliform organisms is negative, a letter and laboratory report shall be submitted by the service organization to the contractor, certifying successful completion of the sterilization.
 9. If any samples tested indicate the presence of coliform organisms, the entire sterilization procedure shall be repeated.
- D. The sanitary, storm water, condensate drain and miscellaneous drain systems shall be hydrostatically tested. Tests shall be as required by code and as a minimum shall comprise the plugging of all openings in the line, filling the system (or portion thereof) with water until all joints are proven tight. Piping shall be tested with a minimum head of 10 feet of water.
- E. All pressure piping systems, unless otherwise specified herein, shall be filled with water and thoroughly flushed clean of foreign matter after erection and before connection of equipment.
- F. All centrifugal pumps shall be dynamically balanced and certified by an independent testing agency. The agency shall specialize in dynamic balancing of equipment and shall be able to demonstrate experience and expertise in dynamic documentation of all testing, including all test information as well as the certification. These documents shall become permanent records of the facility. The contractor shall be responsible to perform any alignment corrections and shall not be released of his contractual obligation until all equipment is certified to be dynamically balanced. All equipment requiring re-alignment shall be re-tested and certified. Submit name of testing company to the owner and engineer for approval.

END OF SECTION 22 00 50

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SECTION 22 05 33

HEAT TRACING FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes heat tracing for Plumbing piping.

1.3 SUBMITTALS

- A. Submit shop drawings for all materials specified in this section in accordance with Section 22 00 50, Plumbing Basic Materials and Methods.
 - 1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
 - 2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.
 - 3. Include diagrams for power, signal, and control wiring.

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

- A. Subject to compliance with requirements, provide products by one of the following:
 - 1. Chromalox, Inc.
 - 2. Raychem; Tyco Thermal Controls.
 - 3. Thermon Americas Inc.
- B. Comply with IEEE 515.1.
- C. Heating Element: Pair of parallel No. 16 AWG, tinned, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, non-heating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.
- D. Electrical Insulating Jacket: Flame-retardant polyolefin.
- E. Cable Cover: Tinned-copper braid and polyolefin outer jacket with ultraviolet inhibitor.
- F. Maximum Operating Temperature (Power On): 150 degrees F.
- G. Maximum Exposure Temperature (Power Off): 185 degrees F.
- H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

I. The heater shall be:

1. Volts: 120
2. Phase: 1
3. Hertz: 60

2.2 CONTROLS

A. Local Thermostat with Ground Fault Protection and Alarm Relay.

1. Remote bulb unit with adjustable temperature range set to activate heat trace at 40 deg F.
2. Two-pole contactor switches up to 30 AMP heater loads.
3. Integral 30ma GFEP.
4. Enclosure shall be corrosion-resistant polycarbonate and NEMA 4X rated.
5. The system shall sense ambient temperature in the general area of the traced pipe and turn heat tracing on when outside temperature is below 40 degrees F and turn the heat tracing off when outside temperature is above 42 degrees F.
6. Remote interface provided via alarm relay. The system shall self-test and alarm for no power, ground fault condition, GFEP function test failure, and damaged thermistor.

2.3 ACCESSORIES

- A. Provide cable installation accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.
- B. Warning Labels: Vinyl-based and installed on the thermal insulation weather barrier. In accordance with the NEC, electrically heated pipelines and vessels are to be clearly identified "at frequent intervals along the pipeline or vessel". Caution labels should be placed at 10'-20' intervals or as required by local code.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. The Division 26 contractor shall be responsible for power wiring and terminations between the electrical power system and the controls. The Division 22 contractor shall be responsible for control wiring and conduit (if required) and the power wiring between the controller and heat trace termination kits. The Division 22 contractor shall provide system layout drawing including cable, control location, sensors, and power connection points. Divisions will be required to coordinate with each other to meet specified installation requirements.

- B. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.
- C. Install Controls per manufacturer's written instruction.
- D. Electric Heating-Cable Installation for Freeze Protection for Piping:
 - 1. Install electric heating cables after piping has been tested and before insulation is installed.
 - 2. Install electric heating cables according to IEEE 515.1.
 - 3. Install insulation over piping with electric cables according to Section 22 07 00 "Plumbing Systems Insulation."
 - 4. Install warning tape on piping insulation where piping is equipped with electric heating cables.
- E. Set field-adjustable switches and circuit-breaker trip ranges by Division 26.

3.3 CONNECTIONS

- A. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
 - 2. Test cables for electrical continuity and insulation integrity before energizing.
 - 3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
- B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.
- C. Cables will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.5 PROTECTION

- A. Protect installed heating cables, including non-heating leads, from damage during construction.
- B. Remove and replace damaged heat-tracing cables.

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SECTION 22 05 93

TESTING, ADJUSTING AND BALANCING FOR PLUMBING 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 the work specified in this section.

1.2 SUMMARY

- A. This section includes all labor and materials necessary to adjust, balance and test [and commission] performance in accordance with design criteria and the equipment and components of systems included in Division 23 as follows:
 - 1. Water Distribution
 - 2. Equipment Performance

1.3 COMMISSIONING

- A. Division 22 will be responsible to carry out the commissioning requirements specified in Division 01, and other sections.

1.4 QUALIFICATIONS

- A. Work included in this section shall be performed by approved contractor who shall test, adjust, and balance the air and water systems for this project in accordance with NEBB or AABC standard procedures.
- B. All work shall be performed under direct supervision of a qualified engineer. All instruments used shall be accurately calibrated and maintained in good working order. If requested, calibration tests of equipment to be used shall be performed in the presence of the Engineer or Owners Representative.
- C. Work included in this section shall be performed by a pre-approved air and water balancing firm, who shall test, adjust, and balance the air and water systems for this project in accordance with NEBB or AABC Standard Procedures. Submit the name and qualifications of the air balance firm for approval within thirty (30) days after award of contract.
- D. Qualifications shall include the name of the technician that will be assigned to this project. The technicians qualifications shall be included and shall include successfully completed projects of similar size and complexity, references, and formal training.
- E. If the Contractor fails to submit the name of an acceptable agency within the specified time, the Architect will select a firm to accomplish the work, and the selection shall be binding at no additional cost to the Owner.

- F. All work shall be performed under direct supervision of a qualified engineer. All instruments used shall be accurately calibrated and maintained in good working order. If requested, calibration tests of equipment to be used shall be performed in the presence of the Engineer.

1.5 TEST REPORT

- A. The balancing agency shall prepare a written report which shall include diagrams and description of procedures together with all recorded test data. The report shall be submitted in bound volumes for a permanent record. Submit four (4) copies of report. A set of contract drawings shall also be submitted. Drawings shall have each air device, flow fitting, pump, fan, and traverse location identified in red ink by a number which shall match identification numbers utilized in the balancing report. Commissioning checklists and functional performance test sheets shall be included in a separate section of final testing, balancing and commissioning report.
- B. Reports shall be submitted in accordance with requirements of Section 01 33 00 Submittal procedures.

1.6 TEST PROCEDURE

- A. Systems may be tested in increments when approved by the Engineer.
- B. When testing and balancing involve the building temperature control systems, cooperate with the temperature control subcontractor to achieve the desired results. All setpoints shall be documented and included with test report.
- C. At the time of the final inspection, recheck in the presence and at the request of the Engineer not to exceed ten percent (10%) of the previously recorded readings from the certified report selected at random from the log by the Engineer.
- D. Permanently mark the settings of valves, dampers, and other adjustment devices so that adjustment can be restored if disturbed at any time. Do not permanently mark devices before final acceptance.
- E. Perform all tests in accordance with NEBB or AABC standard procedures. Any deviation from same must be approved by the Engineer.
- F. Should the basic system or any of its components fail to meet contract requirements, and thereby make the testing and balancing work invalid, notify the Engineer and stop the tests until such time that the failure is corrected.

PART 2 - PRODUCTS

2.1 TESTING INSTRUMENTS

- A. Use instruments of equal or better quality than those described in the technical portions of Associated Air Balance Council National Standards for Testing and Balancing, Heating, Ventilating and Air Conditioning Systems, Fifth Edition, 1989.

- B. Instruments used for balancing air and water systems must have been calibrated within a period of six (6) months prior to balancing. Submit serial numbers, and dates of calibration of all instruments to be used prior to the start of work.
- C. Instrumentation shall include, as a minimum, the following items of equipment:
 - 1. Pressure gauges and fittings.
 - 2. Dry bulb and wet bulb thermometers.
 - 3. Contact pyrometer.
 - 4. Portable flow meter and, if required, orifice plates.
 - 5. Pitot tube and manometers.
 - 6. Alnor Velometer with attachments.
 - 7. Amprobe.
 - 8. Tachometer.
 - 9. Data Loggers

PART 3 - EXECUTION

3.1 GENERAL

- A. Within fifteen (15) days of receipt of notice to proceed, review plans and specifications of systems to be tested, and balanced, to confirm that the arrangement, instrumentation and balancing devices will permit the system to be balanced and tested in the manner described in this section and report to the Engineer any devices which need to be added or any phase of the design which needs to be modified to permit the fulfillment of this contract.
- B. Conduct balancing and testing in accordance with technical portions of the Associated Air Balancing Council--"National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems, Fifth Edition, 1989". Test procedures not in accordance or not described in the standards, i.e., shall be approved by the Engineer in writing.
- C. Provide all labor, testing equipment, and materials required to conduct tests and balance systems,.
- D. System shall be operated at least four (4) hours after stabilized operating conditions have been established before conducting capacity tests. Capacity and performance tests of equipment and systems shall be performed only after balancing is complete.

3.2 WATER DISTRIBUTION SYSTEMS

- A. After the fluid piping system, including strainers have been cleaned and controls are functioning as required under other sections of Division 22, adjust balancing devices installed for this purpose in accordance with the NEBB or AABC technical procedures to obtain the specified fluid flow or heat transfer rate.
- B. Use reading from system flow fittings, when installed, to determine flow quantity. Where fittings are not installed, determine liquid flow by measuring water pressure drop

through devices with known Cv or pressure drop at specific flow rates. Use flow meter compatible with the type of fittings installed.

- C. Where liquid flow balancing cannot be accomplished due to system deficiencies such as excessive or lack of pumping head, inadequately sized motors, pressure drops not determinable or similar problems, prepare a list of such deficiencies and the suggested system modifications and furnish to the Engineer in writing and prior to submission of test report for necessary action.
- D. Specific testing and balancing procedures shall include:
 - 1. Check expansion tank for water level and tank pressure. Record pressure.
 - 2. Check all air vents for operation. Completely eliminate air from water systems.
 - 3. Set and adjust all pumps for proper delivery rates. Record all pump nameplate information. Record pump flow, water temperature, inlet and outlet pressures, and motor voltage amps, and rpm.
 - 4. Set and adjust water flow in all piping system branches and risers including domestic water, and record flow.

3.3 EQUIPMENT PERFORMANCE

- A. Conduct performance tests only after the air and water systems have been balanced and the proper flow rates established.
- B. Test and record capacity of heat transfer equipment including all water heaters and heat exchangers. Include the manufacturer's rated capacity at the test operating conditions with the report. Perform tests where possible at design conditions. If tests are not performed under design conditions, interpolate results to determine capacity at full load operating conditions.
- C. Calculate efficiency of pumps by recognized methods using test data.
- D. Verify installation of equipment, systems and related controls and devices.
- E. Perform functional performance tests (FPTS) and document on FPT forms for:
 - 1. Domestic water heaters
 - 2. Pumps
 - 3. Other equipment and/or systems as required

3.4 COMMISSIONING RESPONSIBILITIES

- A. With respect to Plumbing commissioning, the TAB agency shall
 - 1. Include cost for Plumbing commissioning requirements in the quoted price.
 - 2. Attend commissioning meetings scheduled by the CA prior to, and during, on-site TAB work being done.
 - 3. Submit proposed TAB procedures to the CA and mechanical engineer for review and acceptance.

4. Attend the TAB planning meeting scheduled by the CA. Be prepared to discuss the procedures that shall be followed in testing, adjusting and balancing the Plumbing systems.
5. At completion of the TAB work, submit the final TAB report to the general contractor or construction manager, with copies to the Owner, CA and mechanical engineer.
6. Participate in verification of the TAB report by the CA for verification or diagnostic purposes. This will consist of repeating a sample of 10% of the measurements contained in the TAB report as directed by the CA.
7. Participate in O&M personnel training sessions as scheduled by the CA.

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SECTION 22 07 00

PLUMBING SYSTEMS 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. Work included in this section consists of furnishing all labor, equipment, materials and accessories, and performing all operations required, for the correct fabrication and installation of thermal insulation applied to the following piping, equipment, and plumbing systems, in accordance with applicable project specifications and drawings:

1. Domestic cold-water piping.
2. Domestic hot-water piping.
3. Domestic recirculating hot-water piping.
4. Sanitary waste piping.
5. Storm-water piping.
6. Roof drains and rainwater leaders.
7. Supplies and drains for handicap-accessible lavatories and sinks.
8. Plumbing equipment.
9. Air conditioning condensate and equipment drain piping.

- B. The requirements of Section 22010, Plumbing General Provisions, shall apply to the work specified under this Section.

1.3. DEFINITIONS

- A. The k factor means the number of British thermal units of heat transmitted per (sq. ft.) Fahrenheit temperature difference through a material with flat, parallel sides one inch (1") apart. The material shall be tested and rated according to ASTM Test Method C-177.
- B. The term "Mineral Fiber" as defined above specifications includes fibers manufactured of glass, rock or slag processed from a molten state, with or without binder.
- C. Unless otherwise specified, the term concealed, as used in this specification, shall include all furred spaces, accessible pipe and duct shafts, and spaces above suspended ceilings.
- D. Unless otherwise specified, the word exposed shall refer to all work other than "concealed" work.

1.4. REFERENCES

- A. Thermal insulation materials shall meet the property requirements of one or more of the following American Society for Testing of Materials (ASTM) specifications as applicable to the specific product or use:
1. ASTM C 533-07: "Specification for Calcium Silicate Block and Pipe Thermal Insulation"
 2. ASTM C547: "Standard Specification for Mineral Fiber Pipe Insulation"
 3. ASTM C553 "Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications"
 4. ASTM C585 "Standard Practice for Inner and Outer Diameters or Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System)"
 5. ASTM C 612 "Standard Specification for Mineral Fiber Block and Board Thermal Insulation"
 6. ASTM C 795 "Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel"
 7. ASTM C 1126-04: "Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation"
 8. ASTM C 1136 "Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation"
 9. ASTM C 1290 "Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts"
 10. ASTM G-21 "Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi" (fungi resistance section only)
 11. ASTM G 22 "Practice for Determining Resistance of Plastics to Bacterial (bacteria resistance section only)

1.5. SYSTEM PERFORMANCE

- A. Insulation materials furnished and installed hereunder should meet the minimum economic insulation thickness requirements of the North American Insulation Manufacturers' Association (NAIMA) to ensure cost-effective energy conservation performance. Alternatively, materials should meet the minimum thickness requirements of National Voluntary Consensus Standard 90.1, "Energy Standard for Buildings Except Low Rise Residential Buildings" of the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE). However, if other factors such as condensation control or personnel protection are to be considered, the selection of the thickness of insulation should satisfy the controlling factor. In no case shall the insulation thickness be less than that specified herein.
- B. Insulation materials furnished and installed hereunder shall meet the fire hazard requirement of any one of the following specifications:
1. American Society of Testing of Materials ASTM E 84
 2. Underwriters' Laboratories, Inc. UL 723
 3. National Fire Protection Association NFPA 255

1.6. FIRE RESISTANCE

- A. Except for materials which are subsequently exempted, all materials used as part of the thermal insulation shall have a fire hazard rating not to exceed twenty-five (25) for flame spread and fifty (50) for fuel contributed and smoke developed.
- B. Test factory assembled materials as assemblies.
- C. Determine ratings by the Standard Method of Test for Surface Burning Characteristics of Building Materials, ASTM E-84 or NFPA No. 255.
- D. The following will be required to establish that fire hazard ratings for materials proposed for use do not exceed those specified: (1) label or listing by Underwriter's Laboratories, Inc., (2) certified test report from an approved testing laboratory.
- E. The following materials are exempt from the foregoing Fire Resistant Rating:
 - 1. Jackets of canvas, PVC and nylon.
 - 2. Polyurethane, polystyrene, cork and flexible, closed-cellular insulation.
 - 3. Nylon anchors for securing insulation to equipment.
 - 4. Factory pre-molded one (1) piece PVC fitting and valve covers

1.7. QUALIFICATIONS

- A. Materials submitted shall be standard products of a manufacturer who has been engaged in the production of the products for not less than three (3) years.
- B. The installing sub-contractor shall have at least five (5) years of successful installation experience on projects with similar insulation products.

1.8. QUALITY ASSURANCE

- A. Insulation materials and accessories furnished and installed hereunder shall, where required, be accompanied by manufacturers' current submittal or data sheets showing compliance with applicable specifications listed in Section 1.4 above.
- B. Insulation materials and accessories shall be installed in a workmanlike manner by skilled and experienced workers who are regularly engaged in commercial insulation work.

1.9. SUBMITTALS

- A. Provide shop drawings in accordance with Section 22 00 10 and the General Requirements which shall include all insulation, jackets, finishes, corner beads, etc. Shop drawings shall additionally describe each system or component to be insulated, insulation type and thickness, and method of installation.

1.10. DELIVERY AND STORAGE OF MATERIALS

- A. All of the insulation materials and accessories covered by this specification shall be delivered to the job site and stored in a safe, dry place with appropriate labels and/or other product identification.

- B. The contractor shall use whatever means are necessary to protect the insulation materials and accessories before, during, and after installation. No insulation material shall be installed that has become damaged in any way. The contractor shall also use all means necessary to protect work and materials installed by other trades.
- C. If any insulation material has become wet because of transit or job site exposure to moisture or water, the contractor shall not install such material, and shall remove it from the job site. An exception may be allowed in cases where the contractor is able to demonstrate that wet insulation when fully dried out (either before installation, or afterward following exposure to system operating temperatures) will provide installed performance that is equivalent in all respects to new, completely dry insulation. In such cases, consult the insulation manufacturer for technical assistance.

1.11. COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 22 00 50 and Section 22 00 10.
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.12. SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1. GENERAL

- A. All insulating materials, including adhesives, jackets and coatings, to be used on the project must be delivered to the building in the manufacturer's unopened container and must bear the manufacturer, brand and description of material.
- B. After the necessary tests have been conducted to prove the water systems tight, all piping and equipment to be insulated shall be thoroughly cleaned and then covered. Insulation materials shall be the product of Owens Corning, Knauf, Manville or Armstrong equal to the products specified herein.
- C. Molded pipe insulations shall be manufactured to meet ASTM C 585 and ASTM C 547.

2.2. TYPES OF INSULATION

- A. Refer to insulation type schedule on drawings.

2.3. ADHESIVES, SEALERS AND COATINGS

- A. Provide all adhesives, sealers, vapor barrier coatings etc., compatible with the material to which they are applied. They shall not corrode, soften or otherwise attack such material in either the wet or dry state and must be suitable for the service temperatures.
- B. Any cement, sealer or coating used shall be resistant to vermin and mold and shall be durable. It shall not discolor on aging; and where applied on the final surface of the insulation, it shall be light in color and be capable of being painted.
- C. Adhesives, coatings and compounds shall be equal to the following:
 - 1. Vapor barrier adhesive for sealing joints on pipe insulation - Foster 85-75.
 - 2. Insulating cement - Owens Corning No. 110

2.4. FITTINGS AND VALVE COVERS

- A. Pipe fittings and valves shall be insulated with Owens Corning PVC pre-molded one (1) piece PVC insulated fitting cover and factory pre-cut insulation or approved equal. Fittings shall have edges of one (1) piece cover sealed with Owens Corning vapor barrier pressure sensitive tape or approved equal.

2.5. PROTECTIVE SHIELDING GUARDS:

- A. Protective Shielding Pipe Covers
 - 1. Plastic wraps for covering plumbing fixture. Hot- and cold-water supplies and trap and drain piping as manufactured by Truebro, McGuire Manufacturing, Zurn Industries or Insul-Tect. Comply with Americans with Disabilities Act (ADA) requirements.
- B. Protective Shielding Piping Enclosures
 - 1. Plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping as manufactured by Truebro, Zurn Industries or approved equal. Comply with ADA requirements.

2.6. METALLIC COMPONENTS

- A. Staples shall be outward clinching type of Type 304 or Type 316 stainless steel.
- B. Bands shall be galvanized steel, aluminum, brass, or nickel-copper alloy, of three-quarter inch (3/4") nominal width. The band thickness, exclusive of coating, shall be not less than five thousandths inch (0.005") for steel and nickel copper alloy, seven thousandths inch (0.007") for aluminum, and one hundredth inch (0.01") for brass.
- C. Wire shall be 14-gauge, nickel-copper alloy or copper clad steel, or 16-gauge, soft annealed, galvanized steel.

- D. Wire netting used for exposed surfaces of insulation that is to be cement finished shall be 22-gauge, one- inch (1") galvanized mesh, with continuous 26-gauge galvanized steel corner beads having two and one-half inch (2-1/2") wings.
- E. All exterior piping shall be additionally covered with a sixteen mil (16 mil) (0.4mm) embossed aluminum or stainless steel weatherproof jacket. Jacketing shall be Childers Lock-on type with factory applied poly kraft moisture barrier. Jackets are to be fabricated with continuous Z-lock on the longitudinal seam and sections shall be joined with factory fabricated butt strap and sealant. Fitting shall be insulated and weatherproofed using similar materials.
- F. Where indicated, all piping shall be covered with UV resistant Owens Corning PVC jacketing or approved equal. Installation shall be in accordance with the manufacturer's limitation with regard to surface temperature and thermal expansion. Fittings shall be insulation as prescribed above, jacketed with pre-formed fittings covers matching the outer jacketing.

2.7. INSULATION SCHEDULE:

- A. Refer to insulation schedule on drawings.

PART 3 - EXECUTION

3.1. EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2. PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3. GENERAL

- A. All insulation shall be installed by skilled workmen regularly engaged in this type of work.

- B. Insulation shall be continuous at all hangers, sleeves and openings. Vapor seals shall be provided for all cold surfaces and shall be continuous.
- C. Arrange to permit expansion and contraction without causing damage to insulation or surface.
- D. Actual insulation thickness must be at least equal to the minimum specified in the schedule. Where the manufacturer's rated or nominal thickness is less than the minimum specified, a thicker material or more layers will be requested so that the stated minimum thickness will be attained or exceeded.
- E. Install insulation materials in a first class manner with smooth and even surfaces. Scrap pieces of insulation shall not be used where a full length section will fit.
- F. Unless otherwise specified herein, the application of all insulation materials, accessories and finishes shall be in accordance with the manufacturer's published recommendations.
- G. Insulation materials shall not be applied until all surfaces to be covered are clean and dry; all foreign material, such as rust, scale, dirt, etc., has been removed; and, where specified, surfaces have been painted. Insulation shall be clean and dry when installed and during the application of any finish. The insulation on pipe fittings, valves and pipe joints shall not be installed before the piping is tested and approved.
- H. Omit insulation on the following unless directed otherwise:
 - 1. Brass or copper pipe specified to be chrome plated.
 - 2. Traps and pressure reducing valves, relief piping from safety valves, and unions.
- I. Replace and repair insulation disturbed by testing and balancing procedures.

3.4. PIPE INSULATION

- A. High density pipe saddles shall be provided at all points of support as hereinbefore specified in Section 22 00 10.
- B. Insulate all valves and strainers. Use pre-molded covers and factory precut insulation where applicable. Unions and flanges shall not be insulated except on cold service.
- C. Insulate valves up to and including bonnets, except for cold water valves which shall be insulated over packing nuts in a manner to permit removal for adjustment and repacking.
- D. Insulate strainers in a manner to permit removal of the basket without disturbing the insulation of the strainer. Obtain Engineer's approval of installation method.
- E. Application - Type I Insulation
 - 1. Insulate all pipes in a neat and workmanlike manner. Seal all longitudinal laps of jackets and staple every six inches (6"). Where the piping operates below ambient temperature, the staples shall be coated with vapor barrier adhesive. All

- butt joints shall be wrapped with a three inch (3") minimum wide strip of jacketing material securely sealed in place.
2. Insulate valves and fittings with pre-cut blanket type fiberglass insulation and PVC covers as specified. Insulation shall be of the same thickness as that on adjoining pipe. The ends of the insulation shall be tucked snugly into the throat of the fitting and the edges adjacent to the pipe covering tufted and tucked in, fully insulating the pipe fitting. The one (1) piece PVC fitting cover shall then be secured by stapling, tack fastening, banding or taping the ends to the adjacent pipe covering. Chilled water supply and return piping and cold-water systems piping shall be insulated as above and have all seam edges of the cover sealed with ZESTON vapor barrier adhesive mastic or approved equal. The circumferential edges of cover shall be color matching tape. The tape shall extend over the adjacent pipe insulation and overlap itself at least two inches (2") on the downward side.
 3. Where fittings are operating above ambient they may, in lieu of the preceding paragraph, be covered with a three hour (3 hr.), hydraulic setting, combination insulating and finishing cement having k factor not greater than 0.87 at a mean temperature of two hundred degrees Fahrenheit (200° F). The thickness of this cement shall be such that the surface is substantially flush with the pipe covering. Where the insulation terminates at a fitting that is not covered, the end of the insulation shall be beveled off with this same cement. All fittings insulated in this manner shall be covered by a fabric jacket as specified, which shall be cemented down with lagging adhesive.
 4. Where expansion joints are required to be insulated, they shall be covered with readily removable sections of insulation of same composition and thickness as provided for adjacent piping.

F. Application - Type II Insulation

1. The material shall be slit lengthwise to permit installation or slipped over pipe before connections are made.
2. All joints and seams must be thoroughly bonded, both mechanically and hermetically, by the adhesive recommended by the insulation manufacturer. Also, the manufacturer's recommendations shall be followed as to the adhesive to use where the insulation needs bonding to metal or other material used for any surface treatment where a finish coat of paint is required.
3. All penetrations of the insulation must be thoroughly sealed so that the insulation itself will form a complete vapor barrier. Wherever the insulation terminates, the edges shall be sealed to the metal.

G. Application - Type X Insulation

1. The material shall be applied lengthwise by placing the slit tubing over pipe. Longitudinal joint is made by peeling release paper from adhesive surface and applying pressure along longitudinal joint. Butt ends shall be secured with Armstrong 520 adhesive or approved equal.
2. All joints and seams must be thoroughly bonded, both mechanically and hermetically, by the adhesive recommended by the insulation manufacturer. Also, the manufacturer's recommendations shall be followed as to use where bonding to other materials or metal is required.

3. All penetrations of the insulation must be thoroughly sealed so that the insulation itself will form a complete vapor barrier. Wherever the insulation terminates, the edges shall be sealed to the metal.

3.5. EQUIPMENT INSULATION

- A. Cut or score insulation to fit shape and contour of equipment. Stagger all joints.
- B. Provide permanently fastened angles or plates, where required to support insulation.
- C. Do not cover nameplates. Cut back the insulation and line edges with 26-gauge galvanized steel.
- D. Application - Type VI & IX Insulation
 1. Insulation shall be applied with staggered joints firmly butted and joined. The insulation shall be held in place by steel bands. Bands shall be spaced on not over twelve-inch (12") centers. All joints and voids shall be filled with cement, well troweled into openings. Apply over the insulation surface one inch (1") galvanized wire netting laced together at all edges and wired to the steel bands with 16-gauge soft annealed wire. Over this shall be applied a one-half inch (1/2") thick layer of insulating cement applied in two (2) layers. Install metal corner beads at all corners and edges to provide a permanent installation.
- E. Application - Type VII Insulation
 1. Apply a brush coat of manufacturer's recommended adhesive to dry, clean metal surface covering an area equal to the size of one (1) sheet. Apply a brush coat of adhesive to the back of the sheet, except for a one-half (1/2") wide border around the edges. After adhesive on metal surface and sheet has dried to a non-tacky state, position sheet so that the edges overlap the previously installed sheets by one eighth inch (1/8"). Apply light pressure to adhere a spot in the center of the sheet only and compress butt edges into place. Spread joints and coat with adhesive.

3.6. FINISHES

- A. Canvas jacket shall be provided on all interior exposed piping, equipment, and ductwork herein specified to be insulated. PVC jacket shall be provided on sanitary and storm piping exposed to freezing conditions.
- B. Canvas jacket applied to insulated equipment: Onto the dry cement surface apply a brush coat of Foster Sealfas 30-35 at the rate of 60-70 square feet per gallon. Imbed into wet coating, all canvas jacket smoothed out to avoid wrinkles and lap all seams a minimum of 2 inches. Apply a second brush coat of Sealfas 30-36 to the entire surface at the rate of 60-70 square feet per gallon. Canvas jacket shall be 8 oz. ULC listed, flame spread 25 or less, smoke developed 50 or less.
- C. Where canvas jacket is to be installed on piping, apply Foster 30-36 adhesive to the canvas jacket by dipping to completely wet and saturate the canvas. While wet, position on the insulation and pull tight, bond lap and smooth out all wrinkles. Finish with a sealer coat of adhesive.

- D. Where PVC jacket is to be installed on piping, installation materials and procedures shall be in accordance with the manufacturer's recommendations.
- E. All pipes exposed to the weather shall be covered with aluminum jacket minimum 0.016 inch thick kept in place with aluminum bands 12 inches on center. Longitudinal seams shall be on underside of pipe and horizontal joints shall be lapped 3 inches with aluminum bands at edge of overlap.

END OF SECTION 22 07 00

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SECTION 22 08 00

COMMISSIONING OF PLUMBING 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. The contractor is responsible for commissioning the systems and components in this section.
- B. The commissioning process requirements are outlined in the related sections listed below. Contractor is responsible for complying with all requirements listed therein.

1.3 RELATED SECTION

- A. Section 01 91 13 "General Commissioning Requirements" for general commissioning process requirements.

END OF SECTION 22 08 00

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SECTION 22 11 00

PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. In-line, close-coupled centrifugal pumps. (Type B).
 - 2. Domestic water booster pumps.
 - 3. Elevator sump pumps.

1.3 SUBMITTALS

- A. Submit shop drawings for all materials specified in this section in accordance with section 22 00 50.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the product.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Include plans, elevations, sections, and mounting or attachment details.
 - 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 4. Include diagrams for power, signal, and control wiring.
 - 5. Operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Pump capacities shall be as scheduled on the drawings.
- B. Reference Motor Specification Section 22 00 10 for efficiency and construction compliance. The motors shall be ODP or TEFC design.
- C. Data submitted for approval shall include pump speed and characteristic curves for performance of the impeller selected. Curves shall indicate capacity vs. head, NPSHR, efficiency and brake horsepower for the full range, from shut-off head to free delivery. Manufacturers' pumps may be considered only if pump efficiencies are equal or greater than the basis of design.

- D. Vibration isolation shall be provided as specified in Section 22 00 50.
- E. Base ells or support shall be provided under piping risers from pump and risers shall further be supported by calibrated spring hangers. Where pump arrangement precludes the use of base elbows or comparable supports, piping shall be supported by means of spring-loaded hangers calibrated for the specific use. Pump isolation bases shall be sized to accommodate the support ells.
- F. Pumps shall be selected so that the operating point on the selected impeller curve will be at or to the left of, and not more than 5% below, the point of maximum efficiency. Impeller size for specified duty shall not exceed 90% of volute diameter.
- G. Pumps shall be provided with motors conforming to Section 22 00 10. Motors shall not exceed 1750 rpm unless noted on pump schedule. Pumps shall be non-overloading with respect to nameplate horsepower throughout the impeller performance curve, unless specifically noted on pump schedule.
- H. Suction diffuser, where indicated, angle or straight pattern shall be rated for 175-psig. Construction shall be cast-iron body, end cap, and pump inlet fitting, with bronze startup and stainless permanent strainers; bronze or stainless steel straightening vanes; drain plug, and factory or field-fabricated support.
- I. The flush line to the mechanical seal shall be equipped with a 50 micron cartridge filter or when the pump differential exceeds 30 PSIG, a cyclone separator can be utilized with a signal flow indicator. The mechanical contractor shall change the filters after the system has been flushed and on a regular basis until the pumps are turned over to the Owner. At final acceptance new filters shall be provided.

2.2 CLOSE-COUPLED INLINE (Type "B" Pump)

- A. Pump shall be close coupled vertical or horizontal in-line type, single stage design. The pumps shall be capable of being serviced without disturbing piping connections.
- B. All Bronze construction, suitable for 175 psig working pressure at 250 deg. F. The casing shall incorporate a seal vent line to facilitate air removal and promote continuous water flush across the seal faces. The casing shall have tapped and plugged holes for priming, draining, and gauges.
- C. The impeller shall be of the enclosed type, vacuum cast in one piece and constructed of bronze, ASTM B584. The impeller shall be finished, the exterior being turned and the interior being finished smooth and cleaned. The impeller shall be dynamically balanced. The impeller shall be keyed to the shaft, fastened with a washer, gasket and capscrew.
- D. Shaft sealing shall be accomplished by means of a John Crane Mechanical seal suitable for 225°F operation. The seal shall have a ceramic seat, carbon washer, Buna-N elastomers, and stainless steel metal parts.
- E. The pump shaft shall be ground and polished stainless-steel shaft with stainless steel sleeve.

F. Pumps shall be manufactured by one of the following:

1. Armstrong Pumps, Inc.
2. Taco Pumps
3. Bell & Gossett Pumps
4. Grundfos

2.3 ELEVATOR PIT SUMP PUMP

- A. Contractor shall furnish and install a Stancor Oil-Minder System Pump or approved equal and control to allow water to be automatically pumped from a sump basin without danger of ejecting potentially harmful oily substances into sewers or drainage system. The system consists of:
- B. Stancor Submersible Sump Pump rated as indicated on drawings with Double Mechanical Seal, Cast Iron Impeller and 3600 rpm, 115/60 Motor with Stainless Steel Housing and 16' long cables. A Stainless Steel Oil Sensor Probe shall be mounted on the Pump. Pump shall be UL Approved and with Thermal and Overload Protection.
- C. Junction Box shall be provided with NEMA 4X Enclosure, Factory Pre-Wired to the pump, oil probe and float switches via cables with a Multipin Connector Cable to Remote Control Panel. Contractor to coordinate exact cable length.
- D. Provide Control Panel in a UL, NEMA 4X Fiberglass Enclosure with Visual & Audible Alarms and Auxiliary Contact.
- E. Mechanical Float Switches, one for Normal On-Off operation and one for High Water Alarm, with 16' Cables.
- F. 24" diameter X 24" deep Fiberglass Basin with a Perforated Steel Cover.
- G. The Pump, Control Panel, Float and Sensor Probe shall be ENTELA tested & certified and Approved by the local governing jurisdiction.

2.4 DOMESTIC WATER BOOSTER PUMP PACKAGE (TYPE C)

- A. Provide a factory fabricated and tested packaged variable speed domestic water pressure booster system. Package shall be complete, and shall include base frame, pumps, piping, valves, ANSI 125# flanged (175# WOG) fittings, supports, stainless steel or copper suction and discharge piping headers, variable frequency drives, and controls. Package shall be primed and finish painted with a painting system designed for wet environments. The controls provided with the package shall provide a constant system pressure with pump flow rates scheduled on the Contract Drawings.
- B. The package shall be complete, and in order for it to become fully functional, field connection requirements shall be limited to water piping to the system headers, over temperature drain tube, a single incoming power connection at the control panel, and ATC connections as indicated on the Contract Drawings.

- C. The entire package shall be third party certified by Underwriters Laboratories, Inc. in accordance with OSHA 29 CFR, with references to nationally recognized testing laboratories. Pumps and valves shall be classified for use by U.L., Inc. in accordance with ANSI/NSF Standard 61 for drinking water components. Provide a coating on the inside of the pump suction and discharge headers that shall conform to NSF standards for drinking water, and subject to the authority having jurisdiction.
- D. Submittal data for the booster pump package shall include but not be limited to:
1. System drawings at a scale of 1/2"=1'-0". As a minimum include dimensions in plan, end and side views, including all panels and appurtenances, pumps, piping, valves, fittings, etc. Identify all field connection locations for piping, controls, and electrical power. All pipe and valve sizes shall be indicated.
 2. Individual computer data sheets for the system.
 3. Pump speed and characteristic curves for performance of the pump/impeller selected. Curves shall indicate capacity vs. head, NPSHR, efficiency and brake horsepower for the full range, from shutoff head to free delivery. Pumps will be considered only if pump efficiencies are equal or greater than the basis of design.
 4. Pump, motor, drive, valve, pipe, and fitting data.
 5. Provide a complete description of control panel and VFC's, along with all functions and capabilities, sequencing data, instrumentation and alarms. Provide a wiring diagram for all panels and pump controllers.
- E. Quality assurance
1. The Contract Drawings indicate the size and arrangement of the booster pump package. The Contractor shall note the space constraints and piping connections, and the Contractor and vendor shall verify all dimensions and arrangements before submitting shop drawings to ensure that the package is coordinated with the building access provisions and the utility arrangements shown.
 2. The booster pump package shall be designed with sufficient clearances to enable the removal of an inboard motor or pump around the adjacent pump while keeping the adjacent pumps in operation.
 3. Control panels and VFC's shall be readily accessible and shall meet code required clearances.
 4. Control panels shall be listed in accordance with UL Standard 508A, "Standard for Industrial Control Panels"
 5. Any modifications made by the Contractor or factory to the pump package layout indicated on the contract drawings shall be indicated on the shop drawings, and shall be approved in writing by the Engineer. Package modifications shall be the responsibility of the Contractor for coordination, shall meet the minimum requirements of this specification, and shall be at no additional cost to the Owner.
- F. Booster pumps
1. Pumps shall be vertical, inline, centrifugal, single stage or double suction type, radial split case design, split coupled motor assembly, with rigid spacer type coupling.

2. Select pumps so that the operating point on the selected impeller curve will be at or to the left of, and not more than 5% below, the point of maximum efficiency. Impeller size for specified duty shall not exceed 90% of volute diameter.
3. Provide pumps with premium efficiency motors designed for inverter duty that conform to Section 22 00 10 of these specifications. Motors shall be of scheduled rpm. Pumps shall be non-overloading with respect to nameplate horsepower throughout the entire performance curve for the impeller selected.
4. Casing shall be cast iron for working pressures up to 175 psig at 150°F (125 psig ANSI flange rating) and ductile iron for working pressures to 375 psig at 150°F (250 psig ANSI flange rating). Suction and discharge connections shall be flanged with tapings for seal flush and gauge connections.
5. Impeller shall be of the enclosed type, vacuum cast in one piece and constructed of bronze, ASTM B584. Impeller shall be finished, the exterior being turned and the interior being finished smooth and cleaned. The impeller shall be dynamically balanced, and keyed to the shaft, fastened with a washer, gasket and capscrew.
6. Mechanical seals shall be John Crane stainless steel outside multi spring balanced type with Viton secondary mechanical seals or approved equals rated for 125 psig minimum working pressure and a continuous water temperature of 225°F. Provide bronze gland plate with stainless steel hardware including a factory installed external flush line with manual vent. All pumps shall be provided with a lower seal chamber throttle bushing.
7. The pump shaft shall be ground and polished stainless steel, with stainless steel sleeve.
8. The coupling shall be a rigid spacer type of high tensile aluminum alloy. Couplings shall be split to allow removal from pump and motor shafts, leaving space between the shafts sufficient to replace all mechanical seal components without disturbing the pump or motor. Coupling shall be protected by a removable guard. Filed alignment shall not be required by the coupling design.
9. Pump suction and discharge piping ells shall be supported directly from the package structural base.

G. Valves

1. Each pump shall be provided with the valves specified below. Valves shall be approved for use with potable water:
 - a. High performance full port size butterfly or ball valve on the pump suction. Suction valve shall be upstream of the pump suction diffuser.
 - b. Pump suction diffuser, angle pattern, rated for 175 psig. Construction shall be cast iron body, end cap, and pump inlet fitting, with bronze startup and stainless steel permanent strainers; bronze or stainless steel straightening vanes; drain plug, and factory fabricated support to booster package structural base. Suction diffuser shall be Armstrong, Bell and Gossett, or approved equal.
 - c. Center guided silent check valve at the pump discharge, designed to eliminate water hammer and sized for a pressure drop no greater than 1 psig.
 - d. High performance full port size butterfly or ball valve on the pump discharge, downstream of the check valve.

2. High performance butterfly valves, ball valves, and silent check valve shall meet the requirements of Section 22 01 00 of these specifications.

H. Pump sequencing

1. The discharge header pressure sensor and pump sequencing controls shall be provided with the booster pump package. The package shall include the necessary contacts for transmitting alarms as described in the controls sequence indicated on the Contract Drawings.
2. The booster pump package shall be configured to be manually operated through virtual H O A selector buttons provided on a touch screen operator interface panel provided with the package.

I. Power and control panel

1. Electrical components shall be provided in NEMA 12 enclosures with a touch screen operator interface. A single main disconnect shall be provided. Control panel shall be equipped with virtual Hand off Auto control switches on the display panel for user control of pump motors and variable frequency drives. Control panel shall be complete with 3 leg overload and short circuit protection, 120V control circuit transformer, and integral, fused 24V controller power supply.
2. Short-Circuit Current Rating (SCCR) of panel assembly shall be 5000A RMS Symmetrical Amperes, as determined by UL 508A Supplement SB method or by testing methods approved and verified by the listing agency.
3. Ambient environmental ratings for the controller shall be 0°C to 60°C and 5% to 95% relative humidity, non-condensing.
4. The control panel shall be complete with 3.5" by 4.5" liquid crystal, watertight touch screen operator interface with easy to read backlit display. The operator interface shall have password protected system parameters, onscreen display of pump system parameters such as system pressure (psi), supply pressure (psi), three phase voltages, three phase amperages, pump run status, and percentage of full speed. All system parameters shall be visible on a single screen without scrolling. Access to the inside of the controller shall not be required to change system parameter settings, alarm settings or to reset alarms.
5. The controller shall utilize a 0-10mV or 4-20 mA analog signal with discharge pressure as the control variable. Controls shall be arranged so that two pumps may be energized at any one time with the third pump as standby.
6. Controller design shall include provisions for low flow energy savings, best operating point sequencing, end of pump curve protection, automatic alternation of pumps, built in pump on delay and minimum run timers, resettable pump elapsed runtime meters, smooth pump starting and sequencing, onscreen field modifiable control and alarm parameters, no flow shutdown and other capabilities as described on the Contract Drawings.
7. Provide onscreen alarm display with alarm identification, with the following alarms included: low system pressure shutdown, high system pressure shutdown, low suction pressure shutdown, high suction pressure shutdown, pump failure, controller failure, drive fault, and suction or discharge pressure transmitter failure. The controller shall include onscreen fault description and possible cause information with alarm horn.

8. Provide communication interface for remote EMCS indication, contacts: individual pump status, drive/motor failure, system pressure, and low suction pressure. ATC Contractor shall provide field wiring and sensors to implement the Input/Output points shown on the Contract Drawings.
9. Nonvolatile factory set parameters shall be readily restored at any time in the field without requiring any programming device or connection to an external source. The controller shall hold software in EPROM memory storage to prevent accidental loss of data due to voltage surge or spike.
10. All controls shall be factory prewired and tested in accordance with the provisions of the National Electrical Code. Control wires shall be individually numbered and each component shall be labeled accordingly. Internal wiring shall be copper stranded, A.W.G. with a minimum rating of 90°C. The controller shall bear the UL508 label for industrial controls.
11. Provide surge protection for all controls.

J. Instrumentation

1. Booster pump package shall be provided with manifold mounted liquid filled pressure gauges for indicating suction and discharge pressures. Provide gauges and gauge cocks that conform to Section 22 00 10.
2. Provide a factory prewired and pre-piped temperature probe to assure over temperature protection (continuously operating system).

K. Variable speed drives

1. Provide one variable speed drive for each pump provided in this booster pump package. Variable speed drives shall conform to the requirements of this section.

L. Factory Testing and Certification:

1. The entire booster pump system and its component parts shall be fully assembled and shall undergo a complete operational factory flow test from zero to 100% design flow rate under the specified pressure conditions.
2. The system certification shall include copies of the test data as certified by a factory engineer. Performance test certifications shall be placed inside the control panel with copies in the installation manual.
3. The entire package shall be third party certified by U.L., Inc.

M. Startup Services:

1. Contractor shall provide the services of one factory trained service representative for the installed system to provide a minimum of eight (8) man hours of labor for system startup. As a minimum, manufacturer's representative shall inspect each pump, controller, valve, fitting, all controls, etc, and the entire package installation under this contract, and shall verify proper operation of the system and all its components and accessories, including all field connections made by the installing Contractor.
2. Service representative shall provide written authorization for startup and shall witness startup and provide a factory formatted startup test report for submission to the Engineer.

3. Service representative shall also provide a minimum of four (4) additional hours of field training to the Owner's maintenance personnel at startup for the proper operation and maintenance of the booster pump package. Schedule training with the Owner a minimum of 24 hours in advance.
4. Manufacturer of the booster pump package shall be Tigerflow or approved equal with Aurora pumps, Armstrong, Systecon, or Syncroflow. All submittals shall be certified by an officer of the proposing company that their packaged system complies with these specifications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

3.2 PUMP INSTALLATION

- A. Install in-line, seal less centrifugal pumps with shaft horizontal unless otherwise indicated.
- B. Install horizontally mounted, in-line, close-coupled centrifugal pumps with shaft(s) horizontal.
- C. Install vertically mounted, in-line, close-coupled centrifugal pumps with shaft vertical.
- D. Install all floor mounted pumps and pump packages on concrete housekeeping pads.
 1. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 3. Install anchor bolts to elevations required for proper attachment to supported equipment.
- E. For inline pumps, install continuous-thread hanger rods and spring hangers of size required to support pump weight.
 1. Comply with requirements for vibration isolation devices specified in Section 22 00 50. Fabricate brackets or supports as required.
 2. Comply with requirements for hangers and supports specified in Section 22 00 50.
- F. Install pressure switches in water supply piping.
- G. Install thermostats in hot-water return piping.
- H. Install time-delay relays in piping between water heaters and hot-water storage tanks.
- I. Install piping adjacent to pumps to allow service and maintenance.

- J. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.
 - 1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:
 - a. Horizontally mounted, in-line, close-coupled centrifugal pumps.
 - b. Vertically mounted, in-line, close-coupled centrifugal pumps.
 - c. Comply with requirements for flexible connectors specified in Section 22 00 50.
- K. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping.
 - 1. Install pressure gage and snubber at suction of each pump and pressure gage and snubber at discharge of each pump. Install at integral pressure-gage tapings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Comply with requirements for pressure gages and snubbers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."
- L. Interlock pump between water heater and hot-water storage tank with water heater burner and time-delay relay.

3.3 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 22 00 10.

3.4 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers on suction piping.
 - 4. Set pressure switches, thermostats, timers, and time-delay relays for automatic starting and stopping operation of pumps.
 - 5. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
 - 6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
 - 7. Start motor.
 - 8. Open discharge valve slowly.

9. Adjust temperature settings on thermostats.
10. Adjust timer settings.

3.5 ADJUSTING

- A. Adjust domestic water pumps to function smoothly and lubricate as recommended by manufacturer.
- B. Adjust initial temperature set points.
- C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION 22 11 00

SECTION 22 13 00
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. Cleanouts
 2. Drains
 3. Domestic water pressure reducing valves
 4. Master mixing valves
 5. Emergency fixture mixing valves
 6. Plumbing specialties
 7. Trap priming systems

1.3 SUBMITTALS

- A. Submit shop drawings for all materials specified in this section in accordance with section 22 00 50.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the product.
 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Include plans, elevations, sections, and mounting or attachment details.
 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 4. Include diagrams for power, signal, and control wiring.
 5. Operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 CLEANOUTS

- A. Cleanouts shall be placed in piping throughout the building, where noted and where required by code. Cleanouts on piping below floors, at ends of runs and changes of direction of piping shall consist of Y branches, the full size of pipes to which they are connected with cleanout plugs and covers as listed below or as detailed. Extend cleanouts on concealed piping to finished walls, floors and grade. Cleanouts shall be Josam, Jay R. Smith, Watts, or Zurn equal to Josam numbers indicated below.

1. In concrete floor on grade (generally) - Series 58460A-AE-2 cleanout with scoriated round satin bronze top, bronze cleanout plug with lead seal, and adjustable housing. In carpeted areas, Josam Series 58460A-AE-2-14.
2. At base of vertical piping and in walls - Series 58910 cleanout tee with countersunk bronze threaded plug. Where risers are concealed, provide Series 58600-COT cleanout tee with plug tapped for center screw and stainless steel wall access cover.
3. Cleanouts on exposed horizontal piping shall be Series 58900 with bronze threaded plug.
4. Cleanouts in exterior underground piping shall be countersunk set in four inch (4") extra heavy cast iron pipe extension to grade. Provide Josam Series 58490-20 with taper thread bronze plug set in twelve inches by twelve inches by eight inches (12" x 12" x 8") concrete finished flush with grade.
5. Cleanouts in waterproofed equipment rooms - Series 58460A-AE-2-20 with bronze plug.

2.2 DRAINS

- A. Provide traps for all drains. All sanitary traps shall be "deep seal" type.
- B. Provide drains where indicated. Drains shall be Josam, Jay R. Smith or Zurn equal to Josam (or Watts/Zurn as noted) equipment as follows:

1. Floor Drains – General, with Primer Tap	Type "A" 30000-6A-VP-50 (Nikaloy Top)
2. Floor Drains – General	Type "B" 30000-6A-VP (Nikaloy Top)
3. Floor Drains – Equipment, with Funnel and primer tap	Type "C" 30000-7E3-VP-50 (Nikaloy Top)
4. Floor Drains - Mechanical Room,	Type "D" 32100-11-50 (Cast Super Flow Large Capacity Iron Top)
5. Area / Garage Drains	Type "E" Watts FD-490-F-4
6. Roof Drains (Dual outlet roof drain Overflow combination)	Type "F" Watts RD-700-D
7. Overflow Drain Wall Outlet	Type "H" Zurn ZS199-DC-VP Downspout Cover
8. Trench Drain	Zurn Pro-Plus Trench Drain, 100-GSP-C Series Grate (Load Class C)

2.3 MASTER MIXING VALVE

- A. Furnish and install where indicated master mixing valve, as manufactured by Lawler, Model 804 or approved equal. It shall be sized for a minimum flow of ½ gpm and a maximum flow of 50 gpm.
- B. Master water mixing valve shall be of the thermostatic type with liquid filled motor. It shall have bronze body construction with replaceable corrosion resistant components. Valve construction shall employ a sliding piston control mechanism. Piston and liner shall be of stainless steel material. Valve shall come equipped with union end stop and check inlets with removable stainless steel strainers.
- C. Unit shall include 0-200°F dial thermometer, shut-off valve and union on tempered water outlet. Unit shall be completely assembled and tested with necessary fittings, nipples and escutcheons and installed in a cabinet.

2.4 EMERGENCY FIXTURE MIXING VALVE

- A. Furnish and install where indicated emergency mixing valve, as manufactured by Lawler or approved equal. Valves shall be sized for the capacity scheduled on the drawings and installed in accordance with manufacturers' recommendations.
- B. Emergency water mixing valve shall be of the thermostatic type with liquid filled motor. It shall have bronze body construction with replaceable corrosion resistant components. Valve construction shall employ a sliding piston control mechanism. Piston and liner shall be of stainless steel material. Valve shall comply with ANSI Z358.1-2004 and provide positive hot water shut-off and integral cold water bypass.

2.5 PIPE SPECIALTIES

- A. Manual Air Vents:
 - 1. Manual air vents shall be key-operated type installed where indicated on the drawings or as required for proper venting of equipment. Vents at top of vent chambers or coils shall be 1/4" brass cocks, Crane #2190 H or approved equal.
- B. Pressure Regulating Valves:
 - 1. Pressure regulating valve on water fill lines serving hydronic systems shall be designed for 125 psig working pressure, set as required and shall be Watts Series LFU5B or approved equal. Relief valves shall be Watts Series 174A, ASME stamped or approved equal. Provide unions and pressure gauges upstream and downstream of pressure regulating valves.
- C. Backflow Preventers:
 - 1. Backflow preventers shall be Watts Series LF909 or approved equal, 3/4 inch size and larger, for piping systems. Elsewhere, vacuum breakers shall be Watts, or approved equal, Series 288A No. 9D for equipment and No. 8A for hose bibs.

D. Strainers:

1. Strainers shall be Mueller Steam Specialty Company, Inc., or approved equal, No. 351 for 2" and smaller and No. 758 for 2-1/2" and larger. Screens shall be stainless steel with 1/32" perforations for water. Provide valved blowdown connections on each strainer consisting of a gate valve set between two short nipples. Bush strainer outlet as required for 3/4" maximum connection. Provide a fine mesh start-up screen to be removed after system cleaning.

E. Flowmeter Fittings:

1. Flowmeter fittings shall be Barco or approved equal Venturi type, or Dieterich Annubar type, or approved equal, brass or cast steel construction suitable for 150 psig working pressure and 250 degrees F operating temperature and shall be equipped with brass quick-disconnect valves for connecting flowmeter. The fitting shall have a maximum head loss of one foot water gauge at design rate and shall have an accuracy of plus or minus 5 percent for water temperatures from 40 degrees F to 215 degrees F. Maximum meter reading shall be 50 inches water gauge.

F. Pressure Gauges:

1. Gauges shall be Trerice, Ashcroft, Weiss, Winters, Crosby or Marsh equal to Trerice No. 450 series, liquid filled, 4-1/2" diameter case, bottom connected for easy reading. Dial shall have black letters on white background.
2. Pressure gauges shall be suitable for field calibration.
3. Each gauge shall be mounted within six feet of the floor on background or pipe mounted. Submit gauge locations and scale ranges for approval.
4. Provide Apollo or approved equal 1/4" ball valve where "gauge cocks" are indicated or required.
5. Select gauge such that at normal service the gauge pointer is at the middle of the scale range.

G. Thermometers:

1. Thermometers shall be Moeller, Trerice, Weiss, Taylor, or approved equal. Thermometers shall be bi-metal type with adjustable angle, self-powered (no battery), 3/8" LCD digits display, Hi-impact ABS case, dual F&C switchable, temperature range -40°F-300°F (-40°C-150°C), accuracy +/- 1% or 1°, whichever is greater. Unit shall be complete with brass socket with extension necks for insulated pipes.
2. Thermometer (remote indicating type) shall be Weksler Series X, or approved equal, stainless steel casing, 4-1/2" dial, 0 degrees F to 120 degrees F reading, with Class 5A fully compensating capillary tubing (maximum length 25 feet), air temperature bulb and mounting bracket.

2.6 OTHER SPECIALTIES

- A. Hose connections inside of building shall be Chicago faucet #952 for 3/4" hose thread outlet lock shield cap and removable tee handle Chicago #293-6, polished chrome plated.

- B. Wall hydrants shall be Josam Series 71300-52 or approved equal, non-freeze with satin finish bronze face box and integral vacuum breaker.
- C. Yard hydrant for planters shall be Josam Series 71600-57. See detail on drawings for installation method and depth.
- D. Provide Zurn or Josam shock absorbers equal to Josam Series No. 75000 where indicated, and sized in accordance with PDI Standard WH 201.
- E. Trap Primer:
 - 1. Provide flush valve primers where required and indicated on the drawings. Flush valve primer shall be Precision Plumbing Products Model FVP-1VB (with vacuum breaker), equal by Sloan, Model F-72-A1, or approved equal by alternate manufacturer. Provide 1/2" O.D. copper to floor drain connection.
 - 2. Provide automatic trap priming valve where required and indicated on the drawings. Automatic trap priming valve shall be Precision Plumbing Products PR-500, Prime-Rite or equal by MIFAB, Model MR-500. Provide trap primer distribution unit where required to serve more than one floor drain equal to Precision Plumbing Products DU-4 paired with P1-500 trap primer or approved equals. Provide 1/2" O.D. copper to floor drain connection.
- F. Overflow roof drain downspout nozzle discharge shall be Josam Series 25010-Z-51-BS with satin finish bronze and stainless steel mesh screen.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to 4". Use 4" for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 50 feet for piping 4" and smaller and 100 feet for 5" and larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- F. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.
- G. Assemble and install ASME A112.3.1, stainless-steel channel drainage systems according to ASME A112.3.1. Install on support devices so that top will be flush with surface.
- H. Assemble non-ASME A112.3.1, stainless-steel channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
- I. Assemble FRP channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
- J. Assemble plastic channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
- K. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- L. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- M. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 2. Size: Same as floor drain inlet.
- N. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

- O. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- P. Install frost-proof vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- Q. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- R. Install wood-blocking reinforcement for wall-mounting-type specialties.
- S. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- T. Install piping adjacent to equipment to allow service and maintenance.

3.2 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
 - 2. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings.
- F. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.3 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 13 00

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SECTION 22 34 00

DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Commercial, gas-fired, high-efficiency, domestic-water heaters.
 - 2. Commercial, gas-fired, domestic-water heaters.
 - 3. Domestic-water heater accessories.

1.3 SUBMITTALS

- A. Submit Shop Drawings for all materials specified in this section in accordance with Section 22 00 50.
 - 1. Include construction details, materials descriptions, dimensions of individual components and profiles, and finishes for the product.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Include plans, elevations, sections, and mounting or attachment details.
 - 3. Include details of equipment assemblies, indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 4. Include diagrams for power signal and control wiring.
 - 5. Operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.
- C. ASME Compliance:
 - 1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

1.5 WARRANTY

- A. Manufacturer will repair or replace any part of the equipment supplied by said manufacturer that is found to be defective in workmanship or material within 60 months of substantial completion. Manufacturer shall be notified in writing as soon as the defect becomes apparent.
- B. Each boiler shall be completely tested before leaving the manufacturing factory. This includes a hydrostatic pressure test prior to final assembly and factory test fired prior to shipment. Combustion must be set on all fuels and all firing rates. A factory test fire report and wiring diagram shall be provided with each boiler.
- C. The pressure vessel shall be guaranteed against thermal shock for 10 years (non-prorated) when utilized in a closed loop hydronic heating system with a maximum temperature differential rating of up to:
 - 1. Carbon Steel Units: 170 degrees Fahrenheit
 - 2. Duplex Alloy Steel Units: 100 degrees Fahrenheit.
- D. The boiler pressure vessel shall be guaranteed accordingly without a minimum return water temperature requirement. The boiler shall not require the use of flow switches or other devices to ensure a minimum flow through the boiler.
- E. The pressure vessel shall carry a 10-year warranty against material and workmanship defects. This warranty shall be non-prorated for the first 7 years and years 8-10 shall be pro-rated as per schedule posted on the current product warranty.
- F. The combustor and exhaust pipes (heat exchanger) shall be guaranteed against flue gas corrosion for a period of 10 years on carbon steel boilers or duplex alloy steel boilers. This warranty shall be non-prorated for the first 7 years and years 8-10 shall be pro-rated as per schedule posted on the current product warranty.
- G. All parts not covered by the above warranty shall carry a five-year warranty from project substantial completion. This shall include all electrical and burner components.
- H. The warranty period shall start at the date of overall substantial completion for the project.
- I. Submit a sample warranty for approval before purchasing equipment.
- J. See section 01 77 00 – Closeout Procedures for additional warranty requirements.

PART 2 - PRODUCTS

2.1 GAS-FIRED DOMESTIC-WATER HEATER (WITH REMOTE STORAGE TANK)

- A. The domestic hot water system shall be supplied as a complete package from a single source. The package system shall consist of a Lochinvar Armor (or approved equal) water heater, a jacketed and insulated storage tank, an all bronze circulating pump, inlet and outlet ball valves and an ASME temperature and pressure relief valve.
- B. The water heater shall be a Lochinvar Armor Model WAN (or approved equal) having a capacity as scheduled on the drawings and shall be operated on natural gas. The water heater shall be capable of full modulation firing down to 20% of rated input with a turn down ratio of 5:1.
- C. The water heater shall bear the ASME "H" stamp and shall be National Board listed for inputs in excess of 200,000 Btu/Hr. There shall be no banding material, bolts, gaskets or "O" rings in the header configuration. The stainless steel combustion chamber shall be designed to drain condensation to the bottom of the heat exchanger assembly. A built-in trap shall allow condensation to drain from the heat exchanger assembly. The complete heat exchanger assembly shall carry a five (5) year limited warranty.
- D. The water heater shall be certified and listed by C.S.A. International under the latest edition of the harmonized ANSI Z21.10.3 test standard for the US and Canada. The water heater shall comply with the energy efficiency requirements of the latest edition of the ASHRAE 90.1 Standard. The water heater shall operate at a minimum of 95% thermal efficiency. The water heater shall be certified for indoor installation.
- E. The water heater shall be constructed with a heavy gauge steel jacket assembly, primed and pre-painted on both sides. The combustion chamber shall be sealed and completely enclosed, independent of the outer jacket assembly, so that integrity of the outer jacket does not affect a proper seal. A burner/flame observation port shall be provided. The burner shall be a premix design and constructed of high temperature stainless steel with a woven metal fiber outer covering to provide modulating firing rates. The water heater shall be supplied with a gas valve designed with negative pressure regulation and be equipped with a variable speed blower system, to precisely control the fuel/air mixture to provide modulating water heater firing rates for maximum efficiency. The water heater shall operate in a safe condition at a derated output with gas supply pressures as low as 4 inches of water column.
- F. The water heater shall utilize a 24 VAC control circuit and components. The control system shall have an electronic display for water heater set-up, water heater status, and water heater diagnostics. All components shall be easily accessed and serviceable from the front and top of the jacket. The water heater shall be equipped with; a high limit temperature control certified to UL353, ASME certified pressure relief valve, outlet water temperature sensor, inlet water temperature sensor, a UL 353 certified flue temperature sensor, low water flow protection and built-in freeze protection. The manufacturer shall verify proper operation of the burner, all controls and the heat exchanger by connection to water and venting for a factory fire test prior to shipping.
- G. Provide BACnet interface for connection to the building automation system.

- H. The water heater shall feature the "Smart System" control with a Multi-Colored Graphic LCD display with navigation dial and soft keys, password security, pump delay with freeze protection, pump exercise, and USB PC port connection. The water heater shall feature night setback for the domestic hot water tank and shall be capable of controlling a building recirculation pump while utilizing the night setback schedule for the building recirculation pump. The water heater shall have the capability to accept a 0-10 VDC input connection for BMS control of modulation or setpoint and enable/disable of the water heater, and a 0-10VDC output of water heater modulation rate. The water heater shall have a built-in cascading sequencer with modulation logic options of "lead lag" or "efficiency optimized". Both modulation logic options should be capable of rotation while maintaining modulation of up to eight water heaters without utilization of an external controller. Supply voltage shall be 120 volt / 60 hertz / single phase.
- I. The water heater shall be equipped with two terminal strips for electrical connection. A low voltage connection board with data points for safety and operating controls, i.e., Auxiliary Relay, Auxiliary Proving Switch, Alarm Contacts, Runtime Contacts, Manual Reset Low Water Cutoff, Flow Switch, High and Low Gas Pressure Switches, Tank Thermostat, Tank Sensor, Building Management System Signal, Modbus Control Contacts and Cascade Control Circuit. A high voltage terminal strip shall be provided for supply voltage. The high voltage terminal strip plus integral relays are provided for independent control of the Domestic Hot Water Pump and Building Re-circulation Pump.
- J. The water heater shall have an independent laboratory rating for Oxides of Nitrogen (NO_x) of 20 ppm or less, corrected to 3% O₂.
- K. The water heater shall operate at altitudes up to 4,500 feet above sea level without additional parts or adjustments.
- L. Maximum unit dimensions shall be as indicated on the drawings.
- M. The water heater's firing control system shall be direct spark Ignition with electronic supervision.
- N. The circulating pump shall be furnished by the heater manufacturer as part of the package. The pump shall be all bronze and operate on a 120 volt, 60 cycle, 1 phase power supply. The pump shall be wired to run with intermittent pump operation.
- O. Storage tank shall be a vertical Lochinvar Lock-Temp® "Energy Saver" (or approved equal) tank having a storage capacity as scheduled. The tank shall be constructed with an inner chamber designed to receive all circulation to and from the water heater to eliminate turbulence in the tank. The baffled tank shall supply 80% of tank capacity without a drop in outlet temperature.
- P. The storage tank shall be constructed in accordance with ASME requirements, stamped and registered with the National Board of Boiler and Pressure Vessel Inspectors. The storage tank shall have a working pressure of (125/150) psi. The storage tank shall be glass lined and fired to 1600°F to ensure a molecular fusing of glass and steel, and carry a five (5) year limited warranty. The tank shall be constructed with a heavy gauge galvanized steel jacket assembly, primed and pre-

painted on both sides. The jacket and tank base shall be a water tight construction with a built-in drain pan, complete with a $\frac{3}{4}$ " drain connection to assist in protecting against damage in the event of a tank or component leakage. The storage tank shall be completely encased in high density insulation of sufficient thickness to meet the energy efficiency requirements of the latest edition of the ASHRAE 90.1 Standard. The entire assembly shall be mounted on "I" beam skids to facilitate handling and installation.

- Q. The boiler shall be provided with a disconnect switch.

2.2 FLUE FOR DOMESTIC WATER HEATERS

- A. Direct Vent system with rooftop termination of both the exhaust vent and combustion air. The flue shall be Category IV approved material constructed of Stainless Steel. A separate pipe shall supply combustion air directly to the heater from the outside. The boiler's total combined air intake length shall not exceed 150 equivalent feet. The boiler's total combined exhaust venting length shall not exceed 150 equivalent feet.
- B. Vents shall be a product approved by the appliance manufacturer. For the basis of design Lochinvar Shield domestic hot water heaters, chimneys and vents shall be Simpson Duravent FasNSeal double wall system or approved equal.
- C. Duravent FasNSeal system shall be used for combustion air intake and vent.
- D. Inner Shell: AL29-4C stainless steel.
- E. Outer Jacket: 304 stainless steel.
- F. The stack system shall be installed according to the manufacturer's installation instructions and shall comply with local codes or standards.
- G. The breeching and the stack shall be warranted against functional failure due to defects in material and manufacturer's workmanship for a period of ten years from date of delivery.
- H. Manufacturer's shop drawings showing the actual scaled layout shall be submitted to the Engineer for approval.
- I. The inner diameter or breeching and stack shall be verified by the manufacturer's computations.
- J. The system shall be UL Listed to UL 1738 and ULC S636.
- K. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
- L. Provide boiler adapter, flue termination, and intake air termination in accordance with the appliance manufacturer's recommendations.

2.3 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect assembled domestic-water heaters and storage tanks specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test commercial domestic-water heaters and storage tanks to minimum of one and one-half times pressure rating before shipment.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Install domestic-water heaters on concrete base.
 - 1. Exception: Omit concrete bases for commercial domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
 - 2. Maintain manufacturer's recommended clearances.
 - 3. Arrange units so controls and devices that require servicing are accessible.
 - 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 7. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 8. Anchor domestic-water heaters to substrate.
- B. Tankless, Domestic-Water Heater Mounting: Install tankless, domestic-water heaters at least 18 inches above floor on wall bracket.
 - 1. Maintain manufacturer's recommended clearances.
 - 2. Arrange units so controls and devices that require servicing are accessible.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 5. Anchor domestic-water heaters to substrate.
- C. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
 - 1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping.
- D. Install gas-fired, domestic-water heaters according to NFPA 54.

1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
 2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
 3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
 4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves.
- E. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- F. Install combination temperature-and- pressure relief valves in water piping for domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- G. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains.
- H. Install thermometer on outlet piping of domestic-water heaters.
- I. Assemble and install inlet and outlet piping manifold kits for multiple domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each domestic-water heater outlet.
- J. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.
- K. Fill domestic-water heaters with water.
- L. Charge domestic-water compression tanks with air.
- M. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.
- 3.2 FIELD QUALITY CONTROL
- A. Perform tests and inspections.
1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 22 34 00

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SECTION 22 42 13

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. This section includes all plumbing fixtures to be provided for the project.
- B. The requirements of Section 22 00 10 Plumbing General Provisions shall apply to all work specified under this section.

1.3 SUBMITTALS

- A. Submit shop drawings for all materials specified in this section in accordance with section 22 00 50.
 - 1. Include construction details, material descriptions, dimensions of individual components and finishes for the product.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Include plans, elevations, sections, and mounting or attachment details.
 - 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, methods of field assembly, components, and location and size of each field connection.
 - 4. Include diagrams of power, signal and control wiring.
 - 5. Operation and maintenance manuals.

1.4 CODES

- A. All plumbing products, materials of construction, and joining methods used in the installation or repair of plumbing intended to dispense water for human consumption shall be in compliance with the United States Safe Drinking Water Act and shall meet the limit of weighted average lead content as set forth in NSF/ANSI 372. All such products shall also meet the lead leaching requirements of NSF/ANSI 372.
- B. Provide all plumbing connections required by fixtures and equipment which are provided on this project. Certain items of equipment shall be provided under this section and certain items will be furnished and set under other sections of the specifications. In all cases, provide valved water supplies, waste and vent lines, and,

unless noted otherwise, make final connections after the fixtures and equipment are in place.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Refer to schedule on contract drawings for description and composite for all plumbing fixtures.
- B. Fixtures shall be American Standard, Aquarius, Aqua Bath, Bradley, Crane, Eljer, Elkay, Fiat, Guardian, Just, Kohler, Speakman, Stern-Williams, Zurn, or approved equal, equal to the composite models specified on the drawings.
- C. Trim shall be Chicago, McGuire, Omni, Powers, Speakman, Truebro, or T&S Brass and Bronze Works, or approved equal, equal to the composite models specified on the drawings.
- D. Flush valves shall be Sloan, Zurn or Delany, or approved equal. Flush valve handles shall be located on the "wide side" of the toilet areas for handicapped use.
- E. Toilet seats shall be Church or Olsonite, or approved equal, equal to the composite models specified on the drawings.
- F. Carriers shall be Josam, Jay R. Smith, Watts or Zurn, or approved equal, equal to the composite models specified on the drawings.
- G. Water coolers shall be Haws, Oasis, or Sunroc, or approved equal, equal to the composite models specified herein.
- H. Floor sinks shall be Josam, Jay R. Smith, Watts, or Zurn, or approved equal, equal to the composite models specified herein.
- I. Emergency fixtures shall be Bradley or Speakman, or approved equal, equal to the composite models specified herein.

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 fixture installation.
- B. Examine walls, floors, cabinets, and counters for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install plumbing fixtures level and plumb according to roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-mounted fixtures.
 - 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
 - 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
 - 3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install floor-mounted water closets on bowl-to-drain, connecting fitting attachments to piping or building substrate.
- D. Install counter-mounted fixtures in and attached to casework.
- E. Install water-supply piping with stop on each supply to each fixture to be connected to water-distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
- F. Each fixture and piece of equipment connected to the sanitary system shall be equipped with a trap. Provide traps for storm water lines where required by code. Each trap shall be placed as close to the fixture as possible and no fixture shall be double trapped. All traps on bell and spigot pipe shall be service weight cast iron and all traps on threaded pipe shall be galvanized cast iron recessed drainage type.
- G. Install flushometer valves on water closets.
- H. Install flushometer valves for accessible water closets, with lever handle mounted on wide side of compartment.
- I. Install toilet seats on water closets.
- J. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts. Include adapters if required.
- K. Install laminar-flow, faucet-spout fittings in faucet spouts where laminar-flow fittings are specified.
- L. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- M. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
- N. Set shower pans in leveling bed of cement grout.

- O. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 22 07 00 Plumbing systems insulation.
- P. Seal joints between plumbing fixtures, counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color.
- Q. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings.

3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

3.4 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning plumbing fixtures, fittings, and controls.
- B. Adjust water pressure at faucets and flushometer valves to produce proper flow.
- C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

- A. After installing plumbing fixtures, inspect and repair damaged finishes.
- B. Clean plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed fixtures and fittings.
- D. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 42 13

SECTION 23 00 10

MECHANICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SCOPE

- A. This section describes the general provisions for the mechanical and electrical work included in Division 23. This section applies to all sections of Division 23.

1.3 RESPONSIBILITY

- A. The General Contractor shall be responsible for all work included in the Mechanical Division and the delegation of work to Subcontractors shall not relieve him of this responsibility. Subcontractors who perform work under these Sections shall be responsible to the General Contractor. The term "Contractor" is used throughout this Division and shall mean the General Contractor, although the actual performance of the work may be by a Subcontractor.

1.4 REFERENCE AND DEFINITIONS

- A. Following are definitions of terms and expressions used in the Mechanical Sections. In addition to those used in Division 01 Sections.
 - 1. Owner: State of Delaware, OMB / DFM
 - 2. Architects: Tevebaugh Architecture
 - 3. Engineers: WSP USA Buildings Inc.
 - 4. Concealed - "hidden from normal sight"; includes items in shafts, pipe and duct spaces, and above ceilings.
 - 5. Exposed - "not concealed" - Work within Equipment Rooms and all visible (normal sight) work shall be considered exposed".
 - 6. Piping - includes pipes, fittings, valves, hangers and accessories comprising a system.
 - 7. Ductwork- includes ducts, fittings, housings, plenums, dampers, hangers, and accessories comprising a system.
 - 8. Directed- "directed by the Architect"
 - 9. Indicated- "indicated in Contract Documents"

1.5 STANDARD SPECIFICATION

- A. See General Requirements of the contract.
- B. References to catalogs, standards, codes, specifications, and regulations are the latest edition in effect at date of invitation to bid.

1.6 CODES, REGULATIONS AND PERMITS

- A. Give all necessary notices and obtain all required permits. Pay all fees and other costs, including utility connections or extensions in connection with the work. File all necessary plans, prepare all documents and obtain all necessary approvals of all governmental departments having jurisdiction. Obtain all required certificates of inspection and deliver same to the Architect before request for acceptance and final payment for the work.
- B. All materials furnished and all work installed shall comply with the latest rules, regulations, and recommendations of the following bodies:

ICC International Building Code (IBC)

ICC International Mechanical Code (IMC)

ICC International Plumbing Code (IPC)

Delaware State Fire Prevention Code

NFPA 13, Sprinkler Systems

NFPA 70, The National Electrical Code

NFPA 90A, Installation of Air Conditioning and Ventilating Systems

The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Handbooks

1.7 MATERIAL LIST AND SHOP DRAWINGS

- A. See General Requirements.
- B. Refer to section 01 33 00 "Submittal Procedures" for submittal requirements and procedures.
- C. After receiving approval of equipment manufacturers and prior to delivery of any material to job site and sufficiently in advance of requirements to allow the Architect ample time for checking, submit for approval, dimensioned drawings or cuts showing construction size, arrangement, operating clearances, performance characteristics and capacity of materials and equipment. Each item of equipment proposed shall be a standard catalog product of the approved manufacturer.
- D. Samples, drawings, specifications, catalogs, etc., submitted for approval shall be properly labeled indicating specific service for which material or equipment is to be used, section and article number of specifications governing, and Contractor's name, name of job, and date.

- E. Catalogs, pamphlets or other documents submitted to describe items on which approval is being required shall be specific and identification in catalog, pamphlet, etc., of the item submitted shall be clearly made in ink. Data of a general nature will not be accepted. Any deviations or exceptions taken in the specification by the Contractor shall be so noted.
- F. If material or equipment is installed prior to receipt by the Contractor of approved shop drawings marked "Approved", "No Exception Taken" or "Make Corrections Noted", the Contractor shall be liable for its removal and replacement at no extra charge to the Owner.
- G. The acceptance of shop drawings shall not relieve the Contractor from his responsibility to furnish material, equipment and systems and to perform work required by the contract documents. Neither the Owner nor the Architect will be responsible for errors or omissions on shop drawings furnished by the Contractor even though such shop drawings containing errors or omissions are inadvertently accepted.
- H. The Contractor is further advised that the Architect will not act as coordinator between suppliers and subcontractors. All required coordination shall be the responsibility of the Contractor.
- I. Prepare all submittals as required for LEED certification.

1.8 CONTRACTOR'S USE OF CAD/REVIT FILES

- A. At the Contractor's written request, copies of the Engineer's CAD / Revit files may be made available for Contractor use in connection with the project, subject to following conditions:
 - 1. Submit written request to the Architect listing the specific drawings the Contractor intends to use. Provide a specific list of submittals that the files will be used in preparing, and the list of names of subcontractors or suppliers.
 - 2. The Contractor shall request in writing the electronic transfer agreement. Prior to transfer of files, the Contractor shall prepare a separate electronic transfer agreement for each subcontractor or supplier who will be using the electronic files.
 - 3. Data contained on the electronic files is part of Leach Wallace Associates (LWA) instruments of service and shall not be used for any purpose other than as a convenience in the preparation of shop drawings for the referenced project. Any other use or reuse will be at the Contractor's sole risk and without liability or legal exposure to LWA.
 - 4. The electronic files are not contract documents. Significant differences may exist between the electronic files and the corresponding hard copy contract documents. Because of the possibility the information and data delivered in machine readable form may be altered, whether inadvertently or otherwise, LWA reserves the right to retain hard copy originals of the electronic documentation delivered to the contractor, in machine readable form, which the original shall be referred to and shall govern in the event of any inconsistency between the two.
 - 5. The use of the electronic files, does not relieve the Contractor of their duty to fully comply with the contract documents, including and without limitation, the need to check confirm and coordinate all dimensions and details, take field

measurements, verify field conditions and coordinate work with that of other Contractors for the project.

6. All "internal" calculations integral to / performed by the Revit model shall not be utilized for any purpose by the Contractor. This includes, but shall not be limited to, voltage drop calculations, duct static pressure calculations, air system airflow summary calculations, piping system pressure drop calculations, etc.
7. All Revit "families" are the property of LWA and shall not be re-used on any other project for any purpose by the Contractor.

1.9 GUARANTEE

- A. The Contractor guarantees by his acceptance of the Contract that all work provided shall be free from defects in workmanship and materials for a period of one year after date of certification of completion and acceptance of work. Any defects in workmanship, materials or performance which appear within the guarantee period shall be corrected by the Contractor without cost to the Owner within a reasonable time to be specified in notice from the Architect. In default thereof, Owner may have such work done and charge the cost of same to the Contractor.

1.10 SITE VISIT

- A. Prior to preparing the bid, the mechanical subcontractors shall visit the site and familiarize themselves with all existing conditions. Make all necessary investigations as to locations of existing equipment, ductwork, piping, utilities, etc., work to be removed, and all other matters which can affect the work under the Contract. No additional compensation will be made to the contractor as result of his failure to familiarize himself with the existing conditions under which the work must be performed.
- B. Refer to Section 00 21 13 Instructions to Bidders and Section 00 22 13 Supplementary Instructions to Bidders.

1.11 DRAWINGS

- A. The contract drawings are diagrammatic and indicate the general arrangements of systems and work included in the Contract. Do not scale the drawings. Consult the architectural and structural drawings and details for exact location of structure and equipment; where same are not definitely located, obtain this information from the Architect.

1.12 RECORD DRAWINGS

- A. The Contractor shall keep accurate records of all deviations in work are actually installed from work indicated. One complete set of contract documents shall be available at the construction site for indicating said deviations.
- B. When work is complete, make one (1) complete "As-Built" set of PDF files, certifying the accuracy of each drawing by endorsement and signature thereon and deliver to the Architect who will, after approval, deliver the record drawings to the Owner.

- C. Refer to Section 01 78 39 Project Record Documents for Specific Requirements.

1.13 OPERATION AND MAINTENANCE INSTRUCTIONS

- A. Contractor shall furnish to the Architect two (2) complete bound sets of typewritten or blueprinted instructions and one (1) PDF set for operating and maintaining all systems and equipment included in this Contract. Each set of instructions shall be contained in a hard-back ring binder properly indexed and labeled. Also provide two complete bound sets and one PDF set of approved shop drawings for all items of equipment utilized on the project. All instructions shall be submitted in draft for approval prior to the final issue. Manufacturers' advertising literature or catalogs will not be acceptable for operating and maintenance instructions.
- B. Instructions shall include a general description of each system together with specific instructions describing routine and emergency procedures required of the building maintenance personnel for operating and maintaining each system. The instructions shall include the name or label, location, and function of all operating equipment and controls, and the location of the electrical service and breaker I.D. numbers. Operating modes and the procedures for indexing each mode shall be clearly described. Include lubrication charts and schedules of frequency of lubrication for all equipment designating each point of lubrication and type of lubricant to be used. A listing of names, addresses, and phone numbers of the service organizations for each item of equipment and a typewritten maintenance schedule for same shall be included.
- C. Contractor shall prepare Operations and Maintenance Data and submit in accordance with the requirements of Section 01 78 23 Operation and Maintenance Data.
- D. Upon completion of all work and of all tests, at a minimum the Contractor shall furnish the necessary skilled labor and helpers for operating the systems and equipment for a minimum period of two (2) days of eight hours each, or as otherwise specified. Instruct the Owner's representative fully in the operating, adjustment and maintenance of all equipment furnished. Instruction shall be divided into four (4) sessions of four (4) hours each, each at a time directed by the Owner. refer to individual specification sections for additional training requirements. Refer to Section 01 79 00, Demonstration and Training for specific requirements.
- E. The instructors shall be thoroughly familiar with all parts of the installation on which he is to give instruction and shall be trained in operating theory as well as practical operation and maintenance work. Employ factory trained instructors wherever necessary as determined by the Architect.
- F. During the guarantee period, the Contractor shall service all major equipment items provided under this contract, including chillers, air handling units, and boilers, which require outside service agencies. Service shall not include filter replacement, lubrication of motors and bearings or continuation of water and special system chemical treatment after formal acceptance of the systems by the Architect. Prior to the start of guarantee period, the Contractor shall provide the Architect with a schedule of required maintenance operations for each item of equipment. Submit schedule to the Architect for approval. Thereafter, monthly reports shall be submitted to the Owner for describing actual service provided. Forty eight (48) hours advance notice shall be given to Owner prior to work required under this Section.

1.14 ELECTRICAL WORK

- A. Under Division 23 MECHANICAL, provide the following items of electrical work which shall conform with the applicable requirements of the Electrical Division:
 - 1. Temperature control wiring.
 - 2. Interlock wiring for mechanical equipment.
- B. Under Division 26, 27 or 28, provide:
 - 1. Power wiring complete from source to motor or equipment junction box, including power wiring through motor starters.
 - 2. Motor control centers or motor starter panelboards.
 - 3. All miscellaneous individual motor starters, local wall mounted control devices, unless noted or specified otherwise.
 - 4. All fire alarm interface wiring including smoke detectors located in mechanical systems.

1.15 EQUIPMENT STARTUP AND INITIAL OPERATION

- A. No equipment shall be operated for testing or trial use except after full compliance with the equipment manufacturers' specifications and instructions of the lubrication, alignment direction of rotation, balance, and other applicable considerations.
- B. Particular care shall be taken to see that all equipment is completely assembled and properly lubricated and all grease and oil cases and reservoirs have been filled to the correct level with the recommended lubricant.
- C. It is the Contractor's responsibility to place each item of equipment installed by him in operating condition, including all auxiliaries, piping, wiring, etc., and to start up each unit and check it for performance.

1.16 FIRE PROTECTION

- A. As minimum, one five pound CO2 extinguisher shall be provided with each work crew at all times when working within the building.

1.17 SCHEDULE OF WORK

- A. Refer to project schedule. Specific phasing requirements are to be incorporated into the project schedule. Contactor shall coordinate all work included in this division.

1.18 SERVICE AGENCIES

- A. All mechanical equipment suppliers shall have an established authorized service agency located within the local area. Within 30 days after award of the Contract, the Contractor shall submit to the Architect for approval a list of manufacturers' material and equipment names, including their respective service agency, he proposes to use. In the event any service agency in the list fails to comply with the specification requirement, such service agency will be rejected.

1.19 SINGULAR NUMBER

- A. Where any device or part of equipment is herein referred to in the singular number (such as "valve"), such reference applies to as many such devices as are required to complete the installation, shown, implied or otherwise, as indicated on the drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All materials shall be new, the best of their respective kinds, suitable for the conditions and duties imposed on them at the building and shall be of reputable manufacturers. The description, characteristics, and requirements of materials to be used shall be in accordance with qualifying conditions established in the sections following.
- B. See Division 01 for General Requirements.
- C. All component parts of each item of equipment or device shall bear the manufacturers' name plate, giving name of manufacturer, description, size, type, serial or model number, electrical characteristics, etc, in order to facilitate the maintenance or replacement. The name plate of a subcontractor or distributor will not be acceptable. All equipment requiring electrical service shall be U.L. labeled, or if a U.L. label is not available from the manufacturer, the equipment shall be tested by an approved electrical testing company in accordance with NEC, and at no additional cost to the Owner. Submit data indicating compliance with standards prior to installation.
- D. In specifying materials, four general procedures are used. The four classifications are as follows:
 - 1. GROUP 1: When the material or equipment is specified by name of other identifying information and one name brand only is used, it is considered that the use of that particular item is essential to the project, and the Contractor shall base his proposal on the uses of that item.
 - 2. GROUP 2: When a material or equipment is specified by brand name and other identifying information and two or more brand names are named, it is considered that any one of the brands so named will be performed as desired, and the Contractor shall base his proposal on one of the named brands.
 - 3. GROUP 3: When the material or equipment is specified with the phrase "... or equal..." after a brand name and other identifying information, it is intended that the brand name is used for the purpose of establishing a minimum acceptable standard of quality and performance and Contractor may base his bid proposal on any item which is in all respects equal to that specified and presents essentially the same appearance, size, operation and performance. The Contractor shall be responsible for coordination of the equal product.
 - 4. GROUP 4: When material is specified as complying with the requirements of published "Standard Specification" of trade associations, American Society for Testing and Material, government specifications, etc., the Contractor shall base his proposal on any item which can be shown to comply in all respects to the referred to "Standard Specification."

- E. All substitutions shall be submitted in accordance with Instructions to Bidders and Section 01 25 00 Substitution Procedures. It is distinctly understood: (1) that the Architect will use his own judgment in determining whether or not any materials, equipment or methods offered in substitution are equal to those specified and will fit within the space available; (2) that the decision of the Architect on all such questions of equality is final; and (3) that all substitutions will be made at no increases in cost to the Owner.
- F. Upon receipt of written approval from the Architect, Contractor may proceed with substitution providing the Contractor assumes full responsibility for and makes, at his expense, any change or adjustment in construction or connection with any work that may be required by the substitution of such materials, equipment or methods. In the event of any adverse decisions by the Architect, no claim of any sort shall be made or allowed against the Owner.

2.2 PIPING SUPPORTS, GENERALLY

- A. Piping shall be run parallel with the lines of the building unless otherwise shown or noted on drawings. The different service pipes, valves, and fittings shall be so installed that after the covering is applied there will not be less than 1/2 inch clear space between the finished covering of parallel adjacent pipes. Hangers on different service lines running parallel with each other and nearly together shall be in line with each other and parallel to the lines of the building. Exact location of electric outlets, piping, ducts, and conduits shall be coordinated among the trades so that there will be no interference between lighting fixtures, piping, ducts, and conduits. Where conflicts between the trades result, they shall be resolved by the Contractor to the Architect's satisfaction and at no expense to the Owner.
- B. In general, hangers shall be spaced so as to prevent sag and permit proper drainage and shall not be spaced more than 10 feet apart unless otherwise indicated herein, in Section 23 00 50, or on the drawings. Hangers shall be placed within one foot of each horizontal elbow.
- C. Vertical runs of pipe and conduit not over 15 feet long shall be supported by hangers placed not over one foot from the elbows on the connecting horizontal runs. Vertical runs of pipe and conduit over 15 feet long but not over 60 feet long and not over 6 inches in size shall be supported on heavy steel clamps. Clamps shall be bolted tightly around the pipes and conduits and shall rest securely on the building structure without blocking.
- D. Hangers shall be of manufacturers hereinafter specified in Section 23 00 50. Unless otherwise specified, pipe and conduit hangers and hanger supports shall conform with the following Anvil International figures:
 - 1. Hangers generally shall be Fig. 69, 104, 212, 260 and 300.
 - 2. Hangers Figs. 295 and 212 shall be provided with turnbuckles and eye rods or rods with eye nuts.
 - 3. Turnbuckles shall be Fig. 230 and 114, shall have not less than 1-1/2 inch adjustment, and shall be provided with lockouts.
 - 4. Clamps shall be Fig. 261 or CT-121.

5. Wherever the movement of pipe due to expansion exceeds 3/4 inch per foot of hanger rod length, hangers shall be Figs. 171, 174 and 181.
 6. Roller supports shall be adjustable.
 7. Concrete inserts shall be Fig. 282 or 281.
- E. On copper pipes, hangers in contact with pipe shall be copper plated.
- F. In lieu of individual hangers, multiple (trapeze) hangers may be used for water pipes having same elevation and slope and for electrical conduits as specified hereinafter:
1. Horizontal members shall consist of 1-1/2 inch by 1-1/2 inch No. 12 gauge, cold formed electro-galvanized dipped channels designed to accept special springheld hardened steel nuts for securing hanger rods and other attachments. Provide metal framing system with applicable fasteners, brackets, fittings, clamps, etc. Two or more such channels may be welded together forming horizontal members of greater strength than single channels. Members shall be Kindorf Series B-995, Unistrut, or approved equal.
 2. Each multiple hanger shall be designed to support a load equal to the sum of the weights of the pipes and liquid. The weight of the hanger rods shall be such that the stress at the root of the thread will not be over 10,000 psi at design load, except that no rod shall be smaller than 3/8 inch. The size of the horizontal members shall be such that the maximum stress will not be over 15,000 psi at design load.
 3. Horizontal runs of piping along walls, 4 inch and smaller, exposed or concealed, shall be secured to metal framing system as specified herein. Provide appropriate clamps, brackets and similar attachments to secure piping to vertical members in accordance with applicable sections of the specification.
 4. On copper pipes in contact with horizontal member, provide rubber strip (Vibra Strip or equal) between hanger attachment and copper pipe.
- G. Hanger attachments shall be suitable for each type of hanger and shall be compatible with the building material to which it is secured. Under no circumstances shall pipe support be secured to any other mechanical, electrical or fire protection equipment. Support shall be suspended from building structure only. The type of attachments which shall be used for the various types of building construction encountered are as follows:
1. Steel beams - Fig. 226, or 66 attachments.
 2. Bar joists - Fig. 225, or 60.
 3. Brick or block walls - Fig. 194, 195, 199 or 202 fastened as follows: For light duty, self-drilling anchors in brick and toggle bolts in block; for heavy duty, through bolts with backing plates.
 4. Concrete (New) - Inserts, Fig. 281 or 282. Power driver fasteners may be used for light loading as hereinafter specified.
- H. Welded attachments for securing hangers to piping or to structural steel may be provided in lieu of other attachments specified if prior approval is obtained in the field from the Architect. Welded attachments shall be designed so that the fiber stress at any point in the weld or attachment will not exceed the fiber stress in the hanger rod. Generally, welding shall not be permitted in finished spaces.

- I. On insulated piping at hangers, provide calcium silicate inserts and shields at each point of support, see Section 23 00 50 and Section 23 07 00.
- J. In no case shall wire or perforated strap be used for pipe or conduit support.
- K. Secure all hangers for piping and ductwork to joist and beams. In no case shall supports be secured to underside of metal or wood deck unless otherwise directed in the field by the Architect. Contractor shall submit details of method of attachments for approval to the Architect.
- L. Refer to specification section 07 72 00 for Rooftop supports for mechanical piping and ductwork. Contractor to coordinate exact number and size of supports.
- M. Pipe curb assemblies shall have heavy gauge galvanized steel curb, cap of acrylic clad abs thermoplastic graduated step PVC boots, adjustable stainless-steel clamps and cap fastening screws. Pipe curb shall be model PCA as manufactured by the Pate Company or approved equal. Contractor shall coordinate exact number and size of openings for piping and conduit penetrations of cap.

2.3 SLEEVES AND PLATES

- A. Pipe sleeves through concrete and masonry construction shall be Schedule 40 galvanized steel pipes unless otherwise indicated on the drawings. Openings that cannot be sleeved before slab or wall is poured shall be core drilled. Pipe sleeves through drywall and similar construction shall be sized to pass both pipe and insulation.
- B. Sleeves in existing concrete or masonry walls shall be set and secured with mortar grout and fast drying bitumastic sealant. Caulk the annular space of pipe sleeves with an elastic caulk compound to make installation air and watertight.
- C. Escutcheon plates shall be provided for all exposed pipes and conduits passing through walls, floors, and ceilings in finished areas. Plates shall be chrome plated brass of the split ring type, of size to match the pipe or insulation where installed. Where plates are provided for pipes passing through sleeves which extend above the floor surface, provide deep recessed plates to conceal the pipe sleeves.
- D. Except above suspended acoustical tile ceilings, provide 24 gauge galvanized sheet metal sleeves for all ductwork passing through floor, ceiling or wall construction. Duct sleeves shall be large enough to pass duct with insulation and shall have 1/2 inch flanges returned against the construction material.
- E. Where fire dampers are required, provide sleeves in compliance with code requirements, minimum 18 gauge galvanized sheet metal.
- F. Utilize U.L. approved resilient sealant for all penetration seals. Submit method of sealing for approval.
- G. Where watertight sleeves are indicated or required to suit the installation, provide Link Seal rubber seals, as manufactured by Thunderline Corporation, between pipes and sleeves.

2.4 MOTORS

- A. Provide motors of a size adequate to drive the equipment but in no case less than the size shown or specified. If a motor larger than that specified is required, the Contractor shall bear the expense of changes in foundations, support, wire and conduit connections, circuit protective devices, variable frequency drives, or other affected elements of the system. Each motor shall have sufficient capacity to start and operate the machine it drives without exceeding the motor nameplate rating at the speed specified or at the load which may be obtained by the drive actually provided. Motors shall be rated for continuous duty at 115 percent of rated capacity; base temperature rise on an ambient temperature of 40°C.
- B. Motors for use with variable frequency controllers shall be "Inverter Ready", suitable for variable speed / variable torque applications, designed to withstand a rise time of 0.10 microseconds and a peak voltage of 1600 per NEMA MG1 Section 31 .4 0.4.2.
- C. Motors 1/2 hp and larger shall be 3 phase, Class B, general purpose, squirrel cage, open type, high efficiency, induction motors, unless otherwise specified. Motors smaller than 1/2 hp shall be single phase, open capacitor type in accordance with NEMA standards wound for 115 volts, 60 Hertz, alternating current. Motors 1/6 hp and under may be split phase type.
- D. Motor efficiencies shall comply with the United States Energy and Independence and Security Act (EISA) of 2007 and the latest revision of NEMA Standard MG1 Table 12-2.
- E. Unless otherwise indicated each motor (5 HP or larger) or motor driven equipment (5 HP or larger) shall have a composite power factor (PF) rating of a minimum of 90% when the motor is operating at the design duty defined on the drawings. Power factor correction devices shall be provided to meet the stated criteria.
- F. Devices (such as: capacitors) or equipment (such as: solid state power factor controllers) when required for power factor correction shall be provided with the motors or item or motor driven equipment. The device shall be mounted and wired to the motor by the project electrical contractor.
- G. For a motor or motor driven equipment requiring other than across-the-line starting PF correcting capacitors (or other equipment) shall be connected to motor terminals via a contactor (controller) with a 120 VAC coil. The 120 VAC coil shall be energized via an auxiliary contact on the contactor (controller) used to establish the "run" operating mode for the motor or motor driven equipment.
- H. All motors for use with variable frequency controllers shall include a maintenance free, circumferential, conductive micro fiber bearing protection ring to discharge shaft currents to ground. Bearing protection rings shall be Aegis, model SGR, or approved equal. Bearing protection shall be installed and tested in accordance with the manufacturer's recommendations.
- I. All motors shall have a warranty period of 5 years from date of substantial completion.

2.5 DRIVES FOR MACHINERY

- A. Equip each motor driven machine with a V-belt drive except those which are directly connected. Where factory designed and assembled belt drives which do not conform to the following are proposed to be furnished, such non-conformity must be noted on the submittals and such non-conformity may be cause for rejection of the item.
- B. Select each drive according to the rating and recommendation of the manufacturer for the service with which used, giving proper allowance for sheave diameter, center distance, and arc of contact less than 180 degrees. Size motors driving centrifugal fans so they have a nameplate rating of not less than 5 percent above the total of actual fan brake horsepower and drive loss at specified capacity if the wheel is of other than the forward curved blade type, and not less than 50 percent above the total of actual fan brake horsepower and drive loss at specified capacity if the wheel is of the forward curve blade type.
- C. Belts shall be constructed of endless reinforced cords of long staple Aramit, nylon, rayon, or other suitable textile fibers imbedded in rubber. Use belt with correct cross section to fit properly in the sheave grooves. Carefully match belts for each drive.
- D. Motor sheaves less than 20 HP shall be adjustable pitch type so selected that the required fan rotation speed will be obtained with the motor sheave set approximately in mid-position and have the specified pitch diameter in that position. Motors above 20 HP shall be provided with fixed sheaves to achieve the rated capacity of the fan. During the Commissioning Phase, if required to meet actual system requirements, a second set of sheaves and belts shall be provided and installed.
- E. Select the motor of a capacity needed to operate the equipment at the specified mid-position operating condition. Where non-overloading motors are specified, select the motor sheave. In no case shall motors be a smaller size than those shown.
- F. Do not select fan sheave smaller in diameter than 30 percent of the fan wheel diameter.
- G. Construct sheave of cast iron or steel, bored to fit properly on the shafts and secured with key ways (not set screws) or proper size, except key ways may be omitted for sheaves having 1/2-inch or smaller bores where set screws may be used.
- H. Provide OSHA approved guards for all belt drives, constructed in accordance with SMACNA standards. Submit shop drawings for approval.

2.6 DRIP PANS

- A. Where possible to run mechanical piping elsewhere, do not run mechanical piping directly above electrical (or electronic) work which is sensitive to moisture; otherwise provide drip pans under mechanical piping, sufficient to protect electrical work from leakage. Locate pan immediately below piping, and extend a minimum of 6" on each side of piping and lengthwise 12" beyond equipment protected. Fabricate pans 2" deep of reinforced metal with rolled edges and soldered or welded seams; 16 gauge steel with 2 oz. zinc finish hot dipped after fabrication. Provide 3/4" copper drainage piping, properly discharged, to nearest floor drain, service sink, or as directed in the field.

PART 3 - EXECUTION

3.1 WORKMANSHIP

- A. Each subcontractor shall furnish the services of an experienced superintendent who shall be constantly in charge of the installation of the work.
- B. The quality of workmanship required for each trade in the execution of its work shall be the finest and highest obtainable in that trade working with the materials specified. Workmanship shall be satisfactory to the Architect and his decision as to acceptable quality if final.
- C. Contractor shall provide and execute a Quality Control Plan in accordance with Section 01400 Quality Requirements.

3.2 EQUIPMENT CONNECTIONS

- A. All equipment shall be installed and connected in accordance with the best engineering practice and in accordance with manufacturer's instructions and recommendations. Auxiliary piping, valves, and electric connections recommended by the manufacturer or required for proper operation shall be provided.

3.3 COMMISSIONING RESPONSIBILITIES

- A. The mechanical contractor, and all the sub-contractors and suppliers within Division 23, shall cooperate with the commissioning agency (CA), and other commissioning team members, to facilitate the successful completion of the commissioning process.
- B. The contractor shall assign a representative to the commissioning team, and submit the person's name to the commissioning agency, within one (1) month of the award of the contract. The representative shall have the authority to make decisions on behalf of the mechanical contractor as they relate to the organization and scheduling of HVAC commissioning. The representative shall ensure communications between Division 23 contractors and suppliers and all other commissioning team members, and shall foster the necessary cooperative action. One specific responsibility shall be to attend commissioning meetings, and ensure action items arising from them are attended to as required to allow the commissioning process to proceed on schedule.
- C. The Mechanical Contractor, and all mechanical sub-contractors and suppliers, shall cooperate with the Commissioning Agency in carrying out the HVAC commissioning process. In this context, the Mechanical Contractor shall:
 - 1. Each contractor and sub-contractor in this division shall include in their quotes the cost of participating in the commissioning process as specified herein.
 - 2. Ensure the automatic temperature controls (ATC) contractor performs HVAC commissioning responsibilities as listed in 230900.
 - 3. Provide instruction and demonstrations for the Owner's designated operating staff, in conjunction with the commissioning agency and mechanical engineer, and with the participation of qualified technicians from major equipment suppliers and the controls contractor.

4. Include requirements for submittal data, O&M data, and training information in each purchase order or sub-contract written.
5. Ensure cooperation and participation of specialty sub-contractors such as sheet metal, piping, refrigeration, and water treatment as applicable.
6. Ensure participation of major equipment manufacturing in appropriate start-up, testing and training activities.
7. Attend HVAC commissioning meetings scheduled by the CA.
8. Notify the CA a minimum of two weeks in advance of scheduled equipment and system start-ups, so that the CA may witness system verifications, and equipment and system startups.
9. Provide sufficient personnel to assist the CA as required during system verification and functional performance testing.
10. Prior to startup, inspect, check and confirm the correct and complete installation of all equipment and systems for which system verification checklists are included in the commissioning plan. Document the results of all inspections and checks on the checklists and sign them. If deficient or incomplete work is discovered, ensure corrective action is taken and re-check until the results are satisfactory, and the system is ready for safe startup.
11. Notify the CA a minimum of two weeks in advance, of the time for start of the TAB work. Attend the initial TAB meeting for review of the TAB procedures.
12. Provide equipment and systems startup resources as specified and required. If during an attempted equipment or system startup, deficient or incomplete work is discovered that would preclude safe operation, the startup shall be aborted until corrective action has been taken. Ensure such action is taken and verified before re-scheduling a new startup. Those responsible for deficient or incomplete work will be responsible for the costs associated with rescheduling.
13. Carry out performance checks to ensure that all equipment and systems are fully functional and ready for the CA to witness formal functional performance tests (FPTs).
14. Operate equipment and systems for FPTs in accordance with the commissioning plan and as directed by the commissioning agency. If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered, the FPTs will be stopped by the CA. Those responsible for deficient or incomplete work will be responsible for costs associated with rescheduling. Ensure that all corrections necessary for full and complete system operation as specified are completed; then with the ATC contractor and other applicable sub-contractors, carry out functional performance checks to confirm correct operation before applying to the CA to reschedule the FPTs for the system in question.
15. Prepare preliminary schedule for mechanical system orientation and inspections, O&M manual submission, training sessions, pipe and duct system testing, flushing and cleaning, equipment startup, TAB, and task completion for use by the CA. Update schedule as appropriate throughout the construction period.
16. Attend initial O&M staff training session.
17. Conduct mechanical system orientation and inspection at the equipment placement completion stage.
18. Update drawings to as-built condition and review with the CA.
19. Prepare O&M manuals as specified herein.
20. Participate in the O&M staff training sessions with vendors and contractors.
21. Provide written notification to the general contractor or construction manager and CA that the following work has been completed in accordance with the contract

documents and the equipment, systems and sub-systems are operating as required.

- a. HVAC equipment including all fans, air handling units, dehumidification units, ductwork, dampers, terminals and all Division 23 equipment.
 - b. Refrigeration equipment, pumping systems and heat rejection equipment.
 - c. Fire stopping in the fire rated construction, including fire and smoke damper installation, caulking, gasketing and sealing of smoke barriers.
 - d. Seismic restraints installation to specification; a certification from the seismic restraint engineer meets this requirement.
 - e. Dedicated smoke control systems including stairway pressurization and atrium systems.
 - f. Fire detection and smoke detection devices furnished under other divisions of this specification as they affect the operation of the smoke control systems.
22. Provide a complete set of as-built drawings and O&M manuals to the CA for review.
 23. Integrate installation and programming scheduling with construction and commissioning schedules.
 24. Inspect, check and confirm the correct installation and operation of input and output field points and devices through documented and signed off point-to-point checkouts.
 25. Provide thorough training to operating personnel on hardware operations and programming, and the application program for the system, in accordance with the O&M staff training program in the commissioning plan.
 26. In conjunction with the mechanical contractor, demonstrate system performance to the CA including all modes of system operation (e.g. occupied, unoccupied, emergency) during the functional performance tests (FPTs). If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered, the FPTs will be stopped by the CA. Those responsible for deficient or incomplete work will be responsible for rescheduling costs.
 27. Provide control system technician to assist during system verification and functional performance testing.
 28. Provide support and coordination with TAB contractor on all interfaces between controls and TAB scopes of work. Provide, at no additional cost to the TAB and commissioning agencies, all devices, such as portable operator's terminals and all software for the TAB agency to use in completing TAB procedures.

3.4 WATERPROOFING

- A. Under no circumstances shall waterproofing be damaged or penetrated. Should conditions arise which indicate such necessity, notify the Architect.

3.5 CUTTING AND PATCHING

- A. Cutting and patching associated with the work in the existing structure shall be performed in a neat and workmanlike manner. Existing surfaces which are damaged by the Contractor shall be repaired or provided with new materials and methods similar to existing adjacent work, subject to approval of the Architect. Structural members shall not be cut or penetrated unless otherwise indicated on the drawings. Verify in the

field with the Architect. Holes cut through concrete and/or masonry to accommodate new work shall be cut by reciprocating or rotary non-percussive methods. Existing masonry block walls shall be patched with new masonry or gypsum board attached and sealed to both block faces.

3.6 SURVEYS AND MEASUREMENTS

- A. Base all measurements (both horizontal and vertical) from established benchmarks. All work shall agree with these established lines and levels. Verify all measurements at site and check correctness of same as related to the work. Verify locations of existing utilities and inverts of same prior to the start of any systems shown connecting to utilities.
- B. Should the Contractor discover any discrepancy between actual measurements or conditions and those indicated which prevent following good practice or the intent of the drawings and specifications; he shall notify the Architect and shall not proceed with his work until he has received instruction from the Architect.

3.7 WELDING

- A. Welding shall conform to current standards and recommendations of the National Certified Pipe Welding Bureau, with all Delaware Occupational Safety and Health Acts, State, County and City Fire Prevention Code Requirements, Fire and Safety Regulations, and NFPA Standard 241 including provision of appropriate portable fire extinguisher.
- B. Before assigning any welders to work covered by this specification, the Contractor shall provide the Architect with the names of pipe welders to be employed for the work, together with each welder's assigned number, letter, or symbol which shall be used to identify the work of that welder and which shall be affixed immediately upon completion of the work, copies of each welder's certified qualification tests prescribed by the National Certified Welding Bureau or by other reputable testing laboratory using procedures covered in the American Society of Mechanical Engineers Building Construction Code, Section IX, "Qualification Standard for Welding and Brazing Procedures Welders, Brazers and Welding and Brazing Operators." Welders must be certified for all positions.
- C. If requested by the Architect, the Contractor shall submit identifying stenciled test coupons made by any operator in question. The Contractor shall require any welder to retake the tests when, in the opinion of the Architect, the work of the welder creates a reasonable doubt as to his proficiency. Tests, when required, shall be conducted at no additional expense to the Owner; and the welder in question shall not be permitted to work as a welder on this project until he has been recertified. Recertification of the welder shall be made to the Architect only after the welder has taken and passed the required test; welder must pass the test without benefit or retests in order to resume work as a welder on the project.
- D. Welding for pressurization piping systems shall conform to American National Standards Institute (ANSI) American Society of Mechanical Engineers (ASME) B31.9, "Code for Pressure Piping, Building Services Piping". The Contractor shall be responsible for the quality of welding and shall repair or replace any work not in

accordance with these specifications. Contractor shall, without cost to the Owner, check welds by radiograph, ultrasonic testing, sectioning or a combination of these methods wherever there is a question raised by the Architect as to the quality of a weld; examination of the questionable weld shall be in addition to other system tests specified. Welds shall have penetration complete to the inside diameter of the pipe and the recommended spacing and bevels between ends of pipe prior to welding shall be used in all cases to assure full penetration.

3.8 HANDLING AND STORAGE OF MATERIALS

- A. Proper and suitable tools, equipment and appliances for the safe and convenient handling and placing of all materials and equipment shall be used. During loading, unloading, and placing, care shall be taken in handling the equipment and materials so that no equipment or materials, including Owner furnished, are damaged.
- B. All mechanical and/or electrical equipment delivered to the job site shall be stored under roof or other approved covering, on pedestals above the ground. All enclosures for equipment shall be weatherproof. Any motors which are not totally enclosed, that are involved in the work, shall be stored in a heated area with a minimum temperature of 50 degrees Fahrenheit. All valves shall be stored under roof on wood pedestals above ground. All insulation shall be stored under roof or in trailers, adequately protected from the weather. The Contractor shall follow all written instructions and recommendations of the manufacturer and all requirements of the Architect in oiling, protection and maintenance of equipment during storage. It shall be the Contractor's complete responsibility for the storage and care of the equipment and materials.
- C. If any materials and/or equipment are found to be in poor condition at the time of being installed, the Architect may, at his discretion, order the Contractor to furnish and install new equipment at no cost to the Owner.

3.9 COOPERATION WITH OTHER TRADES

- A. Exact location of air outlets, electric outlets, piping, ducts, and conduits shall be coordinated with all other trades so that there will be no interference between lighting fixtures, piping, ducts, and conduits. Where conflicts between the trades result, they shall be resolved by the Contractor to the Architect's satisfaction and at no expense to the Owner.
- B. Mechanical trades shall give full cooperation to other trades and shall furnish in writing, with copies to the Architect, all information necessary to permit the work of all trades to be installed satisfactorily and with the least possible interference or delay. Exact location of all mechanical equipment in finished spaces shall be coordinated with shop drawings and with elevations indicated on the architectural drawings.

3.10 CLEANING AND PAINTING

- A. Thoroughly clean all exposed surfaces of equipment and material and leave in a neat, clean condition ready for painting. Restore and touch-up factory finishes which have been damaged during construction. Finished painting will be performed under another Division.

B. Miscellaneous requirements include:

1. Provide complete new finish if, in the opinion of the Architect, the factory finishes are severely damaged.
2. Touch up threads of zinc coated screwed pipe with Rustoleum primer and one coat of enamel conforming to painting specification.
3. Paint behind grilles and registers in finished areas with two coats of flat black paint following surface preparation of the zinc coated metal.
4. All exposed hangers, steel supports and miscellaneous components, and cast iron pipe hangers shall be field painted with Rustoleum primer and one coat of enamel conforming to painting specification.
5. All steel support and miscellaneous components shall be painted with Rustoleum primer and one coat of enamel conforming to the painting specification.

3.11 ACCESSIBILITY

- A. Locate all equipment which must be serviced, operated or maintained, in fully accessible positions. Equipment shall include, but not be limited to, air terminal units, coils, valves, motors, controllers, dampers, drain points, etc. Where required and where directed, provide 14 gauge steel access panels, Milcor or equal, to suit material in which installed. Doors installed in fire rated walls or shafts shall be labeled and shall match rating of the construction. Door shall be of sufficient size to allow access to all components, except minimum size shall be 24" x 24", unless otherwise noted.
- B. Equipment deemed inaccessible by the Architect shall be reworked by the Contractor at no expense to the Owner. All doors shall have cylinder locks operable from same key. Submit shop drawings for approval.

3.12 EQUIPMENT BASES AND SUPPORTS

- A. Under this Division provide all equipment supports required for the mechanical work.
- B. Provide structural members and related materials, inertia pads, platforms, and gratings.
- C. All concrete bases, curbs, and supports shall be furnished under this Division unless otherwise indicated.
- D. The Contractor shall furnish all required foundation sizes, bolts, washers, sleeves, plates and templates for equipment.
- E. The size of the foundation bolts shall be as recommended by the manufacturer.
- F. The type and size of the supporting channels and supplementary steel shall be determined by the Contractor and shall be of sufficient strength and size to allow only a minimum, deflection in conformance with manufacturer's requirements for loading. Contractor shall submit details for approval to the Architect.

3.13 EXCAVATION AND BACKFILL

- A. Excavation:

1. Trenches shall be excavated to the necessary width and depth as shown on the drawings. The trench subgrade shall be such as to allow the bedding of the utility with a uniform and continuous bearing on solid, undisturbed earth for the full length of each pipe, except for that portion at the bell ends. The subgrade shall be graded with sufficient accuracy to assure this minimum. The bottom portion of all trenches from the subgrade to a point two feet (2') above the crown or top of the utility shall be as nearly vertical as practicable and at the minimum width.
2. Trenches in fill areas shall not be excavated until embankment construction has been completed to a point at least two feet (2') above the crown or top of the utility being placed.
3. Any part of the bottom of the trench excavated below the specified subgrade shall be back filled, at the Contractor's expense, with bedding materials as hereinafter specified. Whenever wet, or otherwise unstable, subgrade is encountered below the elevation of the original ground surface which existed prior to the time of construction, such soil shall be removed to the depth and extent directed by the Architect and the trench backfilled to the proper grade with bedding material as hereinafter specified. Reimbursement for extra work performed by the Contractor shall be in accordance with General Conditions. Whenever the Architect requires the removal of wet or otherwise unstable subgrade from the fill material previously placed by the Contractor, the cost of all removal of unstable soil, together with backfilling of the trench as herein specified shall be borne by the Contractor.
4. Excavation for manholes and similar structures shall be of sufficient size to leave a minimum of twelve inches (12") and a maximum of twenty four inches (24") clearance on all sides. Any over-depth excavation shall be filled with concrete as directed and at the expense of the Contractor.
5. Provide shoring and sheet piling necessary for excavation and for the safety of personnel and property as directed. Unless otherwise directed, the sides of all excavations over four feet (4') deep must be braced. All shoring, bracing, sheet piling, etc., must be solidly installed heavy timber suitable for the purpose. No lumber shall be buried when excavations are backfilled, except by authority of the Architect.

B. Backfill:

1. No backfill and/or bedding and backfill shall be placed until the construction adjacent or the utility to be backfilled has been inspected, tested and approved. Notify the Architect when inspections are required.
2. Backfill material shall be earth materials only, free from perceptible amounts of wood, debris, or topsoil and shall not contain marble or other elements which tend to keep it in a plastic state. The material shall be free of frost at the time of placement. Backfill for plastic pipes shall be clean sand, free of foreign materials.
3. Bedding materials, for use where trench subgrade is excavated below specified depth or for use at Contractor's option, shall be crushed stone or gravel, meeting the requirements of a S.R.C. No. 6 aggregate or crusher run S.R.C. CR-6 and shall be free of frost at the time of placing.
4. Work broken or ruptured by improperly placed backfill shall be removed and replaced by the Contractor at no additional cost to the Owner.

5. Following inspection as specified above, approved backfill material shall be deposited in the trench with hand shovels, not by means of wheelbarrows, carts, trucks, bulldozers, or similar equipment, in four inch (4") layers and compacted by mechanical tampers until the pipe has a cover of not less than two feet (2'). The remainder of the backfill material shall then be deposited in the trench in eight inch (8") layers and compacted. Any trenches improperly backfilled shall be reopened, then refilled and compacted to the required grade and smoothed off. Backfill shall be placed and tamped to achieve ninety five percent (95%) (percent of dry weight) compaction.
6. Field density tests may be required by the Architect in areas where, in his opinion, a question exists with respect to compliance with compaction requirements. These tests will be paid for at standard rates by the Owner, where the test results indicate compliance with the compaction requirements, and by the Contractor where the test results indicate non-compliance with compaction requirements. Density tests shall be performed by the methods specified in A.A.S.H.O. Designation T-147, the Field Determination of Density of Soil-In-Place.

3.14 SLEEVES AND PLATES

- A. Sleeves shall be provided by the trade installing the pipe or duct. The sleeves shall be carefully located in advance of the construction of walls and floors where new construction is involved. Provide all cutting and patching necessary to set sleeves which are not placed prior to construction. All cutting and patching necessary to set sleeves which are not placed prior to construction shall be the responsibility of the trade providing the sleeves.
- B. Sleeves shall be provided for all piping and ductwork passing through concrete, masonry, plaster and gypsum wallboard construction. Caulk the annular space of pipe sleeves with an elastic caulking compound to make installation air and watertight.
- C. Fasten sleeves securely in the construction so that they will not become displaced when concrete is poured or when other construction is built around them. Take precautions to prevent concrete, plaster or other materials being forced into space between pipe and sleeve during construction.
- D. Sleeves required in existing concrete or masonry walls shall be set and secured with mortar grout and fast drying bitumastic sealant.
- E. At all sleeves where objectionable noise can be transmitted (e.g. Mechanical and Electrical Rooms), at smoke barriers, at walls above ceilings that extend to the underside of the structure of the floor above, or at fire rated separations, seal all openings between pipes and ducts and corresponding sleeves to prevent sound transmission and to maintain fire rating. Use U.L. approved resilient sealant for penetration seals.
- F. Where pipe motion due to expansion and contraction will occur, provide sleeves of sufficient diameter to permit free movement of pipe. Where sleeves pass insulated pipes and ducts, the sleeves shall be large enough to pass the pipe or duct and the insulation. Check construction to determine proper length for various locations; make actual lengths to suit the following:

1. Terminate sleeves flush with walls, partitions and ceilings.
2. Terminate sleeves 2 inches above finished floor in equipment rooms, and wet floor areas.
3. In all other areas, terminate sleeves 1/2 inch above finished floor unless otherwise noted on the drawings or directed in the field.

3.15 ALTERATIONS AND DEMOLITION

- A. All existing piping, equipment, ductwork, and materials which are required to be removed shall be removed. All existing materials and equipment which are removed and are desired by the Owner, or are indicated to remain as the property of the Owner, shall be delivered to him on the premises by the Contractor where directed by the Architect. All other materials and equipment which are removed shall become the property of the Contractor and shall be promptly removed by him from the premises.
- B. Remove all indicated mechanical work by hand as far as possible. Power-driven equipment shall be used as a last resort, and shall not be employed without consent of the Owner. Schedule all demolition work to the satisfaction of the Owner. The Contractor shall execute the removal work as quietly as practicable to avoid unnecessary disturbances to occupied areas.
- C. Existing conditions, i.e. ductwork, piping, equipment, etc, may be obtained from available record drawings and are not warranted to be complete or correct. Contractor shall verify exact location of all ductwork, piping, etc, in the field prior to starting any work.
- D. Existing duct and pipe sizes noted on the available record drawings are for the convenience of the Contractor only. Contractor shall verify sizes in the field.
- E. Existing piping and ducts no longer required to remain in service shall be disconnected and removed back to service mains and trunk ducts, including existing piping hangers, supports, and air devices. Existing pipe and ducts indicated or required to remain in service shall be capped.
- F. Existing piping that remains concealed, buried, or otherwise contained in or below the remaining slabs and walls shall be capped, plugged, or otherwise sealed. All pipes shall be cut so that their capped or plugged ends will be far enough behind finished surfaces to allow for the installation of the normal thickness of finished material.
- G. When existing mechanical work is removed, all related pipes, valves, ducts, and materials shall also be removed.
- H. When the work specified herein connects to existing piping, or ductwork, the Contractor shall perform all necessary alterations, cutting, or fitting of the existing work as may be necessary or required to make satisfactory connections between the new and existing work and to leave the completed work in a finished and workmanlike condition, to the entire satisfaction of the Architect.
- I. When the work specified herein or under other divisions of the contract necessitates relocation of existing mechanical equipment, piping or ductwork, the Contractor shall perform all work and make all necessary changes to existing work as may be required

to leave the completed work in a finished and workmanlike condition, to the entire satisfaction of the Architect, and at no additional cost to the Owner.

- J. Existing mechanical equipment, piping and ductwork affected by removal or new work installation and required to remain in service shall be reinstalled or supported as required in accordance with new work specification. All work shall be completed to the Architect's satisfaction and at no additional cost to the Owner.
- K. Valve off or disconnect live services as required for removal work.
- L. Refer to drawings for additional requirements.

3.16 FLASHING

- A. Openings for pipes and ductwork through waterproofed floors and roof areas shall be flashed. Vent pipes shall be flashed with 4 lb. sheet lead 24 inches square. Flashing shall be extended up around vents, which shall terminate not less than 12 inches above roof, and shall be fastened under vent caps.
- B. Refer to Architectural drawings and specification for additional roof flashing requirements.

3.17 COORDINATED DRAWINGS

- A. Prior to installation of mechanical work in all areas of the building including exposed areas (spaces without ceilings), the Contractor shall prepare completely coordinated layout drawings indicating the coordinated work of all trades involved. The drawings shall be a sheet size similar to the contract drawings. All work shall be to scale minimum $1/4" = 1' - 0"$. The drawings shall include all work shown on the drawings, including equipment (chillers, boilers, air handling units, pumps, water heaters, storage tanks, steam generators, converters, etc), variable frequency controllers, ATC control panels, terminal units, ductwork, air devices, dampers, piping including sprinkler and plumbing, valves, light fixtures, electrical cable trays, raceways and conduits 2" and larger.
- B. All trades shall be responsible for the preparation of the coordinated layout drawings. Each trade shall provide written certification that the coordinated drawings have accurately incorporated their work, and that all conflicts are resolved or a solution is proposed on the drawings. The Contractor shall schedule the trades accordingly and shall provide final certification that all coordination has been completed.
- C. No work shall be installed prior to the Architect's approval of the drawings. The Contractor shall submit for approval of the Architect within 15 days after the award of the contract a schedule of proposed building areas to be grouped for coordination. Upon approval of the schedule, work may commence in areas of the building upon approval of that area's coordinated drawings prior to approval of another area.

3.18 CLOSE OUT PROCEDURES:

- A. Refer to Section 01 77 00 Close Out Procedures for specific requirements.

516 N. KING ST, WILMINGTON DE 19801
NOVEMBER 22, 2024

CUSTOM HOUSE RENOVATION AND ADDITION
#MJ0217000003-BP4

END OF SECTION 23 00 10

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SECTION 23 00 50

HVAC BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This section includes requirements for items of equipment, materials and procedures which are common to more than one section of Division 23 and which are general in nature and use. This section applies to all sections of Division 23.
- B. The requirements of Section 23 00 10 HVAC, Mechanical General Provisions, shall apply to all work specified under this section.

1.3 COMMISSIONING

- A. Division 23 will be responsible to carry out the commissioning requirements specified in Section 23 00 10, and 23 08 00.

1.4 SUBMITTALS

- A. Submit shop drawings for all items of materials specified in this section in accordance with the Section 23 00 10 and Division 01 requirements.
- B. At a minimum, manufacturer's product data shall include specifications, installation instructions and general recommendations for each type of material required. Include data substantiating that proposed materials comply with specified requirements for each type.

1.5 TESTS AND ADJUSTMENTS

- A. The Contractor shall furnish labor, instruments, equipment, and materials required to perform tests prescribed in the sections describing the various systems.
- B. Replace or repair defects found during inspection or test with new materials. Caulking of welded joints, screwed joints, cracks, or holes is not acceptable. Correct leaks in screwed fittings by remaking joints. In welded systems leaks in joints shall be cutout and rewelded. Repeat tests after defects have been eliminated.
- C. Where reasonable doubt exists as to a system's ability to comply with contract requirements, perform any reasonable test required by the Architect.

- D. Make static pressure tests and prove to the satisfaction of the Architect that the piping is tight before pipes are concealed or insulated. Tests shall be provided as hereinafter specified.
- E. Use test instruments for accuracy by an approved laboratory or by the instrument manufacturer and furnish certificates showing degree of accuracy to the Architect when requested. Make calibration histories for each instrument available for examination.
- F. Where gauges, thermometers and other instruments which are to be left permanently installed are used for tests, do not install until just prior to the tests to avoid possible changes in calibration.

PART 2 - PRODUCTS

2.1 HANGERS

- A. Refer to Section 23 00 10.
- B. Hangers and accessories shall be Anvil International, Fee and Mason, Modern, National, or B-Line of the types specified in Section 23 00 10.
- C. It shall be the responsibility of the Contractor to provide an adequate pipe suspension system in accordance with recognized engineering practices, using standard, commercially accepted pipe hangers and suspension equipment.
- D. The design of all hangers and support shall be in accordance with the provision of the current issue of MSS-SP-58 document developed as a standard by the Manufacturers' Standardization Society.
- E. Hangers for steel pipe, except as noted otherwise shall be spaced at least every ten (10') feet. Hangers for cast iron pipe shall be provided at each joint. Hangers for copper and fiberglass pipe shall be placed at least every eight (8') feet, except pipes 1 1/4" inch and smaller shall have hangers at six (6') foot intervals. Polyvinyl chloride pipe (PVC) shall have hangers at four (4) foot intervals.
- F. Where concentrated loads of valves, fittings and similar items occur, or if recommended by the piping manufacturer, closer hanger spacing will be necessary.
- G. Generally, hangers shall be clevis type, standard weight.
- H. Vibration hangers shall be provided as specified.
- I. On insulated piping systems, provide Pipe Shields, Inc., Model CS-CW or approved equal hanger shields at each point of support. Diameter of hanger shield shall match thickness of the insulation. In lieu of, provide wood dowel insert and minimum twenty gauge protection shield at each point of support. Diameter of insert and shield shall match thickness of the insulation and encompass 50% of insulation surface. On cold systems seal insert vapor tight with appropriate coating.
- J. Hangers in direct contact with copper piping systems shall be copper plated.

2.2 IDENTIFICATION AND EQUIPMENT TAGS

- A. All control devices, i.e. panels, switches, starters, push button stations, temperature controls etc., shall be clearly identified as to their function and the equipment controlled.
 - B. All mechanical equipment shall be marked to clearly identify said equipment and space or duty they serve. All air terminal units and their corresponding thermostats shall be marked with sequential numbers to identify each terminal unit with its respective control thermostat.
 - C. Mechanical equipment herein specified shall be identified using engraved laminated black and white phenolic legend plates. Letters shall be minimum, 3/4" high white on surrounding black. Plates shall be mounted by means of sheet metal screws. Submit nameplate list to Architect for approval.
 - D. Mechanical and electrical equipment, i.e., air terminal units, valves, etc., concealed above ceiling shall be identified as to location using clear plastic self-adhesive tape with black lettering, applied to ceiling tile "T" bars. Submit nameplate list to Architect for approval.
 - E. Piping shall be identified with colored, pre-rolled, semirigid plastic labels as manufactured by Seton, Marking Services, Inc., or approved equal. For indoor installations, labels shall be Seton "Set Mark" system. For outdoor installations, labels shall be Seton "Ultra Mark" system. Labels shall be set around pipes with a field installed high strength cement around pipes with a field installed high strength cement compound applied along their longitudinal edge. Labels shall be placed around the piping or insulation every ten feet (10) and with a minimum of one (1) label in each room. A label shall be placed at every major valve and at least six feet (6) from exit or entrance to an item of equipment. At Contractor's option, piping concealed above suspended ceilings only, may be identified by stenciling with black paint and taped color bands in accordance with the coding system herein specified.
1. Labels shall be provided in accordance with the following table with color coding and stencil designations as indicated:

SIZE OF LETTERS

Outside Diameter of Pipe (Inches)	Length of Color Field (Inches)	Size of Letters (Inches)
3/4" to 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"

Over 10" 32" 3-1/2"

2. Color coding and stencil designations shall be as follows:

<u>Service</u>	<u>Color</u>	<u>Stencil Designation</u>
Hot Water Heating Supply	Yellow	Hot Water Heating Supply
Hot Water Heating Return	Yellow	Hot Water Heating Return

- F. Ductwork shall be identified by stenciling. Stenciled lettering shall be minimum 3 inches high with adjacent direction of air flow arrows. Stenciled lettering shall be provided on all mains and principle duct branches. Mark each type of service every 30 feet with a marking of each shaft. Identify ductwork as follows:

Air Handling Units AHU-

Return Systems RF-

Exhaust Systems EF-

- G. All valves, except as specified below, shall be provided with colored plastic or brass valve tags with stamped-in numbers. Tags shall be secured to valve wheels with metal chain. Stop valves on individual fixtures or equipment where their function is obvious, or where the fixture or equipment is immediately adjacent, need not be so equipped. Care shall be exercised in selecting valve numbers to be prepared on tracing linen showing locations, details of arrangements, etc., of all service and control valves indicating identity and function. One black line print of each drawing shall be mounted under glass where directed. Valve tags shall be Seton or approved equal minimum 1-1/2" round tags with white characters describing system and valve designation. Submit valve number list for approval.

2.3 PIPES, FITTINGS AND JOINTS

A. General

1. Piping materials shall conform to state and local code requirements. Pressurized piping systems shall conform to American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME) B31.9, "Code for Pressure Piping, Building Services Piping". High-pressure piping shall conform to ANSI/ASME Section I, B31.1, "Code for Pressure Piping, Power Piping".
2. Quality and weight of materials shall comply with requirements of applicable American Society of Testing Materials (ASTM), ANSI, ASME, and Cast Iron Soil Pipe Institute (CISPI) standards. ASTM number and wall thickness shall be indicated on each pipe length.
3. Provide pipe and fittings for systems as hereinafter specified. All references to codes shall apply to the latest year. Grooved products may be as manufactured by Victaulic or Grinnell. All piping and fittings shall be made in America.

B. Pipe materials

1. Hot Water Heating Supply and Return, 2-1/2" and larger (contractor shall provide one of the following)
 - a. Black steel pipe
 - 1) ASTM A53B seamless ANSI Schedule 40 with steel butt-welded fittings ANSI B16.9 using long turn ells, ANSI B16.5 weld neck or slip-on flanges & Bonney Forge Weldolets and Threadolets. Joints shall be welded in accordance with the Engineering Standards of the Mechanical Contractors Association of America Inc., Part VII, Standard Procedure Specifications Nos. 1 and 2. Piping 12" and above shall be standard weight. Fittings shall be "Made in America."
2. Hot Water Heating Supply and Return, 2" and smaller (contractor shall provide one of the following)
 - a. Black steel pipe
 - 1) ASTM A53A ANSI Schedule 40 with black malleable iron 175 lbs, screwed fittings, ANSI B16.3, joints threaded in accordance with the American Standard for pipe threads, ANSI B2.1. Fittings shall be "Made in America."
 - b. Seamless copper water tube
 - 1) ASTM B88, Type L, hard tempered with wrought copper solder joint fittings 150 lbs., ANSI B16.22. Joints soldered with ASTM B32 tin-antimony 95.5 or Taramet Sterling "lead free" solder or equivalent. All solder joints shall comply with ASTM B828 2002, and shall use ASTM B813 2010 for flux to comply with the LEED Innovation credit: PBT source reduction – lead, cadmium and copper.
 - 2) Alternate fitting - Press Fitting: Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed or an alternative supplied by fitting manufacturer. Press ends shall have SC (Smart Connect) feature design (leakage path).
3. Natural Gas Piping, 2-1/2" and larger
 - a. Black steel pipe
 - 1) ASTM A53A ANSI Schedule 40 with wrought steel butt welded fittings ANSI B16.9. Joints shall be welded in accordance with the Engineering Standards of the Mechanical Contractor's Association of America, Inc., Part VII, Standard Procedure, Specification Nos. 1 and 2.
4. Natural Gas Piping, 2" and smaller

- a. Black steel pipe
 - 1) ASTM A53A ANSI Schedule 40 with malleable cast iron screwed drainage fittings, ANSI B16.12. Joints shall be threaded in accordance with the American Standard for pipe threads, ANSI B2.1.
- 5. Refrigerant Piping
 - a. Piping shall be seamless copper tubing, hard drawn type K or L, ASTM B280 with solder joint fittings, ASME/ANSI B16.22. Piping connections to equipment less than 1" in outside diameter may be soft annealed copper tubing ASTM B-180 with flared tube fittings, UL-109.
- 6. Air Conditioning Condensate and Equipment Drainage:
 - a. Copper drainage tubing
 - 1) All sizes - DWV, ASTM B306 with wrought copper and bronze drainage fittings, ANSI B16-29 with soldered joints: Taramet Sterling "lead free" solder or equivalent. . All solder joints shall comply with ASTM B828 2002, and shall use ASTM B813 2010 for flux to comply with the LEED Innovation credit: PBT source reduction – lead, cadmium and copper.

2.4 VALVES

- 1. General:
 - a. Valves shall be provided where indicated on drawings and as herein specified.
 - b. Valves shall be placed in such a manner as to be easily accessible for handwheel operation and stuffing maintenance.
 - c. Valves in piping where shown and where listed herein:
 - 1) To balance flows in heating water piping.
 - 2) To isolate all items of equipment.
 - 3) To isolate motorized flow control valves.
 - 4) To isolate branch lines and riser at mains.
 - d. Valve pipe connections shall be screw, solder, welded, flanged or Victaulic as required to be consistent with other parts of the piping system.
 - e. Where piping or equipment may subsequently need to be removed, provide valves with bodies having integral flanges or full lugs drilled and tapped to hold valve in place so that downstream piping or equipment can be disconnected and replaced with blank-off plate while valve is still in service.
 - f. In mechanical rooms, valves over ten feet above standing level and above 4" in size shall have chain wheel with chain extending to within six feet of standing level. All wheel operated valves shall have an indicator to show the position of the disc or plug.
 - g. Install valves in accessible locations and adjust for smooth and easy operation.

- h. Valves for equipment and controls shall be installed full size of pipe before reducing size to make connection.
 - i. Where there is no interference, shut-off valves shall be installed with handwheel down on horizontal runs of pipe to prevent accumulation of foreign matter in packer between seats at closing end of wedge.
- 2. Balancing Valves:
 - a. Provide balancing valves where indicated and required to balance water flow through the piping system. For pipe sizes 2 1/2" and larger provide separate balancing valve and flow meter fitting.
 - b. Balancing valve for system piping shall be DeZurik, Homestead or approved equal eccentric plug valve as follows: flanged 2-1/2" and larger, with Fluorinated Hydrocarbon filler in a PTFE U-ring (packing) and CIIR or EPDM plugs and Chloro-Isobutene Isoprene plug facing suitable for -20 degrees F to 250 degrees F continuous operation. Valves shall have lever actuators with adjustable memory stop. For 2" and smaller, provide combination balancing and flow fitting with screwed ends as manufactured by Nexus, Tour & Anderson, or approved equal.
- 3. Butterfly Valves - General HVAC Duty:
 - a. Butterfly valves shall be provided in hot water systems size 4" and larger.
 - b. Butterfly valves shall be Crane/Centerline, Nibco, Bray or DeZurik equal to DeZurik Model BGS resilient seated butterfly valve installed with welding neck companion flanges.
 - c. Butterfly valves shall be of the lug body style suitable for use with ANSI 125 or 150 pound flanges. Bodies shall be ductile iron, or cast iron. Valves shall be manufactured in accordance with MSS-SP67 rated at least 200 psi non-shock cold water working pressure. Bodies of all flangeless wafer valves shall have 4 flange bolt guides to center the body in the pipeline. Body to have 2" extended neck for insulating.
 - d. All valves shall have retained seat and shall provide bubble tight shutoff up to the full valve rating without the use of downstream flanges.
 - e. All valves shall be furnished with bronze self lubricated bearings. Shaft seals shall be provided to prevent leakage and to protect bearings from internal or external corrosion. Bearings shall be provided at the operator connection and at points immediately outboard of the seat.
 - f. Seats shall be of the reinforced resilient type. Seats shall also act as a body liner to prevent flow from contacting the body casting. Seats shall have flange sealing to provide a positive seal without use of flange gaskets.
 - g. Shafts shall be one piece and shall be of Type 416 stainless steel, and shall not have exposed stem-to-disc fasteners. Shaft diameter shall meet the 75B standard from AWWA specification C504-87 for butterfly valves. Shafts shall be finish ground to minimize bearing and shaft seal wear. Shafts of 12" and larger shall have non-adjustable thrust collar.
 - h. Discs shall be aluminum bronze, with EPDM rubber seat. The disc-to-shaft connections shall be Type 316 stainless steel. Pins, shaft and disc of all valves shall be individually machined and completely interchangeable.
 - i. Actuator for valves shall be lever type with locking trigger with notched quadrant. Sizes 8" and larger shall have weatherproof gear operators. All

actuators shall have adjustable memory stops. All actuators manual or automatic shall be provided by the valve manufacturer.

- j. Valves shall be lug-style and capable for use as isolation valves and recommended by the manufacturer for dead-end service at full pressure without the need for downstream flanges.
- k. Each valve shall have a metal tag permanently affixed to the valve listing the following information:
 - 1) Manufacturer.
 - 2) Valve model/series designation.
 - 3) Valve body material.
 - 4) Disk material.
 - 5) Seat material.
 - 6) Certified pressure rating.

4. Ball Valves:

- a. Ball valves shall be used in lieu of gate valves in all hot water heating piping systems size 3" and smaller for shut-off service. Ball valves shall be Apollo, Red White Valve Corp, Jomar, or approved equal.
- b. The body and bonnet shall be ASTM B283 brass. Ball shall be Type 316 stainless steel. Stem shall be stainless steel. Seats shall be RPTFE.
- c. Stem shall be blowout proof and externally adjustable to compensate for wear. Valve shall be equipped with vinyl covered lever handle which shall indicate position of ball orifice and shall have stops for fully open and closed position. Construction shall be such that power actuator can be used. Ball opening shall be full pipe size.
- d. Valve shall be suitable for flow in either direction and shall be rated 150 psig SWP and 600 psi CWP for sizes 1/4"-2" and 400 psi CWP for sizes 2-1/2"-4". Valve shall be capable of performing in systems with operating temperatures between 0 deg F and 400 deg F.
- e. Valve shall be so constructed with two piece cast brass bodies, full port design, with adjustable stem packing.
- f. Ball valves used for balancing shall have adjustable memory stop. For use in insulated piping systems provide 2" extended handles of non-thermal conductive material.

5. Drain Valves:

- a. Drain valves shall be ball valves with hose end connections and shall be provided at low points of all piping system and where indicated or required, 3/4" minimum. Provide Nibco Series 585-70-HC or approved equal. Valve shall be rated for 125 lbs.

6. Gas Valves:

- a. Gas valves shall be SMG Valves Key Port Valve, Figure 425 with lever actuator, or approved equal, AGA approved.

7. Valve Schedule:

a. Unless otherwise specified, valves shall be Grinnell, Stockham, Crane, Jenkins, or Nibco equal to the Nibco figure numbers indicated herein:

b. Hot Water Heating:

1)	Ball - 3" and smaller	
2)	Check - 2-1/2" and larger	Mueller No.105-MAT
3)	Check - 2" and smaller	T-413-B
4)	Check - Solder end	S-413-B

Note: Check valves at pump discharge shall be in line spring loaded or swing design with weight or lever and spring.

2.5 PIPE SPECIALTIES

A. Manual Air Vents

1. Manual air vents shall be key-operated type installed where indicated on the drawings or as required for proper venting of equipment. Vents at top of vent chambers or coils shall be 1/4" brass cocks, Crane #2190 H or approved equal.

B. Pressure Regulating Valves

1. Pressure regulating valve on water fill lines serving hydronic systems shall be designed for 125 psig working pressure, set as required and shall be Watts Series U5B or approved equal. Relief valves shall be Watts Series 174A, ASME stamped or approved equal. Provide unions and pressure gauges upstream and downstream of pressure regulating valves.

C. Automatic Air Vents

1. Automatic air vents on water systems shall be Spirotherm, Sarco, Bell, and Gossett, or Amtrol equal to Spirotherm air release valve, 150 psi, and 250° operating temperature. Provide shut-off valve on each vent. Vents above suspended ceilings shall have 1/4" soft copper drain line extended indirect to nearest floor drain, service sink or drain line.

D. Strainers

1. Strainers shall be Mueller Steam Specialty Company, Inc., or approved equal, No. 351 for 2" and smaller and No. 758 for 2-1/2" and larger. Screens shall be stainless steel with 1/32" perforations for water. Provide valved blowdown connections on each strainer consisting of a gate valve set between two short nipples. Bush strainer outlet as required for 3/4" maximum connection. Provide a fine mesh start-up screen to be removed after system cleaning.

E. Flowmeter Fittings

1. Flowmeter fittings shall be Barco or approved equal Venturi type, or Dieterich Annubar type, or approved equal, brass or cast steel construction suitable for 150 psig working pressure and 250 degrees F operating temperature and shall

be equipped with brass quick-disconnect valves for connecting flowmeter. The fitting shall have a maximum head loss of one foot water gauge at design rate and shall have an accuracy of plus or minus 5 percent for water temperatures from 40 degrees F to 215 degrees F. Maximum meter reading shall be 50 inches water gauge.

F. Pressure Gauges

1. Gauges shall be Trerice, Ashcroft, Weiss, Winters, Crosby or Marsh equal to Trerice No. 450 series, liquid filled, 4-1/2" diameter case, bottom connected for easy reading. Dial shall have black letters on white background.
2. Pressure gauges shall be suitable for field calibration.
3. Each gauge shall be mounted within six feet of the floor on background or pipe mounted. Submit gauge locations and scale ranges for approval.
4. Provide Apollo or approved equal 1/4" ball valve where "gauge cocks" are indicated or required.
5. Select gauge such that at normal service the gauge pointer is at the middle of the scale range.

G. Thermometers

1. Thermometers shall be Moeller, Trerice, Weiss, Taylor, or approved equal. Thermometers shall be bi-metal type with adjustable angle, self-powered (no battery), 3/8" LCD digits display, Hi-impact ABS case, dual F&C switchable, temperature range -40°-300°F (-40°-150°C), accuracy +/- 1% or 1o, whichever is greater. Unit shall be complete with brass socket with extension necks for insulated pipes.
2. Thermometer (remote indicating type) shall be Weksler Series X, or approved equal, stainless steel casing, 4-1/2" dial, 0 degrees F to 120 degrees F reading, with Class 5A fully compensating capillary tubing (maximum length 25 feet), air temperature bulb and mounting bracket.

H. Water Filters

1. Filter housings shall be McMaster-Carr Filter Bag Housing Model 5168K333 or approved equal (6" diameter, 28" high, 1" NPT). Housing shall be constructed of stainless steel with operating pressure rating of 125 psig and maximum temperature rating of 300 degrees F. The housing shall be equipped with heavy duty 302 stainless steel mesh retainer basket.
2. Filter bags shall be replaceable multi-filament type and shall maintain the system with less the 20 ppm suspended solids and particle sizes less than 300 microns.
3. Provide owner with enough filters for initial operation and system clean up and ten complete replacements, after system is accepted.

2.6 PIPE ANCHORS

- A. All pipe lines shall be anchored where specified herein, indicated on drawings and where required to prevent uncontrolled movement. Anchors shall be constructed of steel and plates, assembled by bolting or welding and secured to the building structure by means of clamps or welding. Structural members shall not be cut or drilled. Anchors shall prevent both axial and lateral movement of the lines. Anchor vertical pipes by means of clamps welded to pipe and secured to wall or floor construction. Submit details of anchors to Architect for approval.
- B. Anchor piping adjacent to flexible pipe connectors to prevent connector from expanding against its restraining bolts and also to keep the pipe on both sides of the connector in alignment.

2.7 EXPANSION (WATER SYSTEMS)

- A. Where expansion joints are indicated or required, select joints with a traverse of 150 percent of the pipe expansion from the ambient 40 degrees F to the maximum system operating temperature.
- B. All expansion joints shall be suitable for minimum operating pressure and temperature of 150 psi and 300 degrees F, respectively. Expansion joints 2" and larger shall have flanged ends, except when installed in copper pipe systems.
- C. Submit for approval manufacturer's shop drawings of each expansion joint provided depicting length of pipe, location of anchors and guides, calculated expansion offset and type of joint employed.
- D. Expansion joints shall be as herein specified:
 - 1. Loop Expansion Joints
 - a. Provide flexible hose expansion loop(s) as indicated on the contract drawings or as required to accommodate any thermal expansion, contraction or seismic movement of the piping system.
 - b. Flexible hose expansion loops shall be manufactured complete with two parallel sections of corrugated metal hose, compatible braid, 180 deg return bend, with inlet and outlet connections. Field fabricated loops shall not be acceptable.
 - c. Flexible loops shall be capable of movement in the $\pm X$, $\pm Y$, and $\pm Z$ planes.
 - d. Flexible hose expansion loops shall impart no thrust loads to system support, anchors or building structure.
 - e. For flammable liquid or gas service up to 4", flexible expansion loops shall be CSA / AGA certified.
 - f. All flexible hose expansion loops shall be manufactured in accordance with the documented manufacturers weld procedure specifications. The procedure qualification record shall be used to document the execution of this procedure and shall follow the general "guidelines" of ASME Section IX. Each individual welder shall conform to the in-house procedure qualification record and be qualified prior to each production lot. The testing of each individual welder shall be documented in a welding procedure qualification record.

- g. Flexible hose expansion loops to be Metraloop as manufactured by The Metraflex Company or approved equal.
- h. Corrugated Hose shall be stainless steel with 304 stainless steel braid,
- i. Fittings Materials of construction and end fitting type shall be consistent with pipe material and equipment/ pipe connection fittings. Copper fittings shall not be attached to stainless steel hose.
- j. Flexible hose expansion loops shall have a factory supplied, hanger / support lug located at the bottom of the 180 degree return.
- k. Flexible hose expansion loop(s) shall be furnished with a plugged FPT to be used for a drain or air release vent, and hanger lug at the bottom of the 180 degree return.

2.8 PIPE GUIDES

- 1. Provide pipe guides where indicated on drawings or where required for proper installation of expansion loop. Limit use of guides with expansion loop to point shown or where required to prevent buckling of pipe whether indicated or not.
- 2. Do not use pipe guides as pipe supports.
- 3. Provide factory made cast semi-steel or other heavy fabricated steel consisting of bolted two-section outer cylinder and base with a two-section guiding spider welded or bolted tight to the pipe of sufficient size to clear pipe insulation and long enough to prevent over-travel of spider in cylinder. Furnish a guide sleeve of a length not less than the length of pipe expansion plus the spider length.
- 4. When installed in cooling systems, guides shall permit the application of thermal insulation.

2.9 VIBRATION ISOLATION

- 1. General
 - a. Mechanical equipment and associated piping and ductwork shall be mounted on vibration isolators as specified and required to minimize transmission of vibrations and structure-borne noise to building structure or spaces.
 - b. Select vibration isolating units for the lowest operating speed of equipment so designed that natural frequency of equipment and base mass is not less than 1.5 times the lowest operating frequency of the moving equipment but not a multiple or harmonic of the base frequency. Furnish vibration isolation producing a uniform loading and deflection even when equipment weight is not evenly distributed, and be stable during starting and stopping of equipment without excessive traverse and eccentric movement of equipment.
 - c. Concrete pads under the isolation units shall be reinforced. Use concrete having a minimum compressive strength of 2500 psi and structural reinforcing bars conforming at ASTM A-615 Grade 60.
 - d. The installed vibration isolation system for each floor or ceiling mounted item of equipment shall have a maximum lateral motion under equipment start up and shut down conditions of 1/4". Motions in excess shall be restrained by approved spring type mountings.

- e. All electrical connections, drain connections, etc., made to equipment which rests on vibration isolators, shall be sufficiently flexible to permit the equipment to be properly isolated.
- f. The type of isolation, base, and minimum static deflection shall be as required for each specific equipment application, but no case less than that specified herein when supported on a solid concrete structural slab having a thickness of not less than 4". If vibration isolators with a deflection greater than the minimum specified are required to meet the noise criteria for the adjacent spaces, suitable isolation systems shall be submitted. Should vibration isolators installed for the equipment prove inadequate to prevent transmission of equipment vibrations to the building structure or limit equipment vibration originated noises in the building spaces to acceptable levels, the isolators shall be replaced with units having the largest deflection that can be practicably installed.
- g. Spring and combination rail and spring isolation supports where designated in the schedule are indicated for equipment structurally built or supported on a rigid structural steel frame suitable for these types of isolation. Where these types of isolation are not suitable for the equipment construction or operation, the equipment shall be mounted on a structural steel base as herein specified.
- h. Equipment affected by wind pressure or with operating weight different from installed weight shall have built-in adjustable vertical stops to prevent rising of equipment when weight is removed.
- i. Inertia bases shall consist of a steel reinforced concrete slab cast into a welded structural steel channel frame. Frame shall be fabricated of sufficient strength to prevent distortion of any type during construction, and when the equipment is in operation. Equipment anchor bolts with bottom plates and pipe sleeves shall be preset. One-half inch steel reinforcing bars shall be placed on 6" center both ways in a layer 1-1/2" above the bottom of the base; bars shall extend inside channel frame flanges not less than 1".
- j. Where required due to equipment configuration, the inertia block construction shall change and the concrete thickness shall increase as necessary for the proper mounting of the equipment. The weight of the inertia base shall be equal to or greater than the weight of the equipment supported. Additional weight necessary to reduce vibration or motion caused by the equipment's unbalanced forces to less the 1/32" movement shall be provided when necessary.
- k. Concrete sub-bases not less the 4" shall be provided for all floor mounted mechanical equipment under another Division. Sub-bases shall rest on a structural floor and shall be reinforced with steel rods and interconnected with floor. A minimum clearance of 2" shall be provided between sub-bases and all inertia blocks, steel bases, and steel saddles with equipment in operation.
- l. Each electric motor shall be mounted on the same foundation as the driven machine. Piping connections including strainers at pumps shall be supported on the same foundation as the pumps.
- m. All exterior vibration isolation shall be hot dip galvanized.

2. Vibration Isolation Equipment

- a. All isolation equipment shall be Mason Industries, Kinetics Noise Control, Vibration Eliminator, Amber/Booth, or Korfund equal to the following Mason Industries products:
- 1) Type II Mounting - Stable Springs. Mason Type SLF.
 - 2) Type IV Hanger - combination spring and double deflection neoprene element. Mason Type 30N.
 - 3) Type V Hanger - similar to Type IV with elevation holding device. Mason Type PC30N.
 - 4) Type VII Hose - Flexible pipe connector. Mason Type SFEJ or approved equal, with control rods.
 - 5) Type VIII Mounting - Type II Mounting with horizontal thrust restraints. Mason Type WBI or WBD.
 - 6) Type IX Base - structural steel base form for floating concrete base. Provide base of sufficient length to support pipes as indicated. Mason Type K.
 - 7) Type X Hose - Butyl rubber expansion joints with control rods.
- b. Application Of Isolation Equipment

<u>Item</u>	<u>Type</u>	<u>Deflection</u>
Pumps – Based-mounted	II & IX	0.75"
Piping – Hangers within 50ft of isolated equipment	V	1.50"
Piping – First two hangers near non-isolated equipment	IV	0.75"
Vane Axial Fans – Floor-mounted	VIII	1.50"
Flexible Pump Connectors	VII	---
Pipe Expansion Joint	X	---
Flexible Chiller Connectors	VII	---

2.10 MISCELLANEOUS EQUIPMENT

A. Pressurized Diaphragm Type Expansion Tanks

1. Provide for the hot water heating systems where indicated on the drawings pressurized diaphragm type expansion tanks as manufactured by Amtrol, Armstrong, B&G, or Taco equal to Taco Series CA or CAX. Capacities shall be indicated. Submit selection calculations for approval.
2. Each tank and system shall be air pre-charged to the initial fill pressure of its respective system, suitable for a maximum working pressure of 125 psig and furnished with ASME stamp and certification papers. Tanks shall have

replaceable elastomer diaphragm suitable for an operating temperature of 240 degrees F. Provide air charger tank connection.

B. Test Plugs

1. Pressure and temperature test plugs where indicated or required shall be 1/4" npt fittings, suitable to receive either a 1/8" OD temperature or pressure probe. Fittings shall be solid brass with Nardel valve core, fitted with a color coded marked cap with gasket. The entire assembly shall be rated at 1000 psig. Provide two (2) pressure gauge adapters and two (2) 5" stem thermometers, 0 to 220 degrees F and 20 to 130 degrees F range. Plugs shall be as manufactured by Peterson Equipment Company, Inc., Richardson, Texas or Sisco plugs.

C. Air Eliminator and Dirt Separator

1. Furnish and install as shown on the drawings a Spirotherm or approved equal air and dirt separation fitting on the hot water heating system. All fittings shall be fabricated steel, rated for 150 psig design pressure and be selected for less than 1 foot of water pressure drop and velocity not to exceed 4 feet per second through the unit at specified GPM. Performance curves from the unit manufacturer shall be furnished as part of the submittal for each unit. Units to include internal copper coalescing medium to facilitate maximum air and dirt separation and suppress turbulence. Alternate units shall be furnished with galvanized steel strainer and stainless steel collector tube for a similar purpose. Provide integral high capacity float actuated air vent at top fitting of tank. Alternates must include cast iron float actuated air vent rated at 150 psig which shall be threaded to the top of the fitting. Unit shall have the bottom of the vessel extended for dirt separation with the system connection nozzles equidistant from the top and bottom of the vessel and include a blowdown connection and valve.

PART 3 - EXECUTION

3.1 CLEANING

- A. After completion of installation, thoroughly clean dirt, rust, loose scale, oils and grease, and other foreign matter from metal and insulated surfaces, painted or unpainted, specified under Division 23 of the specification.
- B. Clean all systems piping thoroughly of grease, metal shavings, welding beads, or other refuse. Flush piping by use of portable pump or separate water supply to prevent damage to existing or new system pumps. Before cleaning closed systems, all air handling coils and fan coil units shall be isolated by closing inlet and outlet valves and opening the by-pass valves. The system shall be filled with sufficient detergent and dispersant added to remove all dirt, oil, and grease. System shall be circulated for at least 48 hours after which a drain valve at the lowest point shall be opened and allowed to bleed while the system continues to circulate. Bleeding shall continue until water runs clear and all detergent is removed. A sample of the water shall be tested and, if PH exceeds the PH of the make-up water, draining shall be resumed. After flushing, clean strainers of debris, open coils and close by-passes. Remove dirty water filters and install new water filters. Turn over replacement bag filters to Owner. Refill and vent water systems being sure to add water after venting to completely fill system.

3.2 PIPING INSTALLATION

- A. Install piping without undue stress or strain in locations shown and run parallel to the lines of the building, except to grade them as specified in a neat and workmanlike manner using a minimum of fittings. Provide such fittings, valves, and accessories as may be required to meet the conditions of the installation. Contractor shall inform himself fully regarding any peculiarities and limitations of space available for installation of material under each section of specifications. Install piping to suit necessities of clearance with ducts, conduits, structure, and other work, and so as not to interfere with any passages or doorways and allow sufficient head room at all places. Use proper reducing fittings for changing piping sizes.
- B. Do not install piping through transformer vaults, elevator equipment rooms or other electrical or electronic equipment spaces. Do not route piping over electrical-distribution panels.
- C. Cut pipes accurately to measurements established in the field in a neat and workmanlike manner without damage or without forcing or springing. Perform cutting by means of an approved type of mechanical cutter of the wheel type where practicable. Ream pipe after cutting to remove all burrs.
- D. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories which may be required. Carefully investigate the architectural, structural, and existing conditions affecting the work, and arrange such work accordingly, providing such fittings, and accessories as may be required to meet such conditions.
- E. Install unions and flanges where shown and on each side of all pieces of equipment and other similar items, and in such a manner that the unions or flanges can be readily disconnected. Do not place any union or flange in a location which will be inaccessible after completion of the project.
- F. Unions in steel pipe 2-1/2" and smaller for water service, shall be 250 lb. malleable iron brass, seat type. Use 150 lb. forged steel flanges for piping 3" and larger. Gaskets shall be 1/8" thick rated for 150 psi service at 250 degrees F. Unions in copper pipe 2" and smaller shall be wrought copper with red bronze ring nut. Use 150 lb. ASME copper flanges for piping 2-1/2" and larger. Flanges and gaskets for use in steam and condensate systems shall be rated for system operating pressures.
- G. Use dielectric unions or couplings at all junctions of copper or brass piping and fittings with ferrous material to prevent electrolysis and galvanic corrosion.
- H. Joints between dissimilar piping material shall be made with appropriate adapters in accordance with the respective manufacturer's printed instruction and recommendations.
- I. Use reducing fittings, eccentric where required to prevent pocketing of air and water or both, to make changes in pipe sizes.
- J. Grade pipe minimum 1" in 40 feet to low points, unless otherwise specified or indicated. Provide drain valves at all low points.

- K. Automatic temperature control valves furnished by the control manufacturer shall be installed by the mechanical contractor under the control manufacturer's supervision.
- L. Install wells in hot water heating systems for automatic temperature control sensors. Exact locations and number of wells required shall be determined through coordination with the work required under Section "Automatic Temperature Control."
- M. All piping shall be so installed so that it will in no way be distorted or strained by expansion or contraction. Except as noted, all expansion and contraction shall be taken up by means of swing joints, loops, bends or long offsets. Swing joints made up with at least three fittings shall be provided in branches from mains to runouts. Size loops for the total pipe expansion without cold springing, but field cold spring one-half the pipe expansion corrected for ambient temperature.
- N. Brazing, bending, forming and assembly of refrigerant piping shall conform to ASME/ANSI B31.5.
- O. For installation of refrigerant piping, cut pipe to measurements established at the site and work into place without springing or forcing. Install piping with sufficient flexibility to provide for expansion and contraction due to temperature fluctuation. Where pipe passes through building structure, pipe joints shall not be concealed, but shall be located where they may be readily inspected. Install piping to be insulated with sufficient clearance to permit application of insulation. Install piping as indicated and detailed, to avoid interference with other piping, conduit, or equipment. Except where specifically indicated otherwise, run piping plumb and straight and parallel to walls and ceilings. Trapping of lines will not be permitted except where indicated. Provide sleeves of suitable size for lines passing through building structure. Braze refrigerant piping with silver solder complying with AWS A5.8. Inside of tubing and fittings shall be free of flux. Clean parts to be jointed with emery cloth and keep hot until solder has penetrated full depth of fitting and extra flux has been expelled. Cool joints in air and remove flame marks and traces of flux. During brazing operation, prevent oxide film from forming on inside of tubing by slowly flowing dry nitrogen through tubing to expel air. Make provisions to automatically return oil on halocarbon systems. Installation of piping shall comply with ASME/ANSI B31.5.
- P. Install refrigerant lines so that gas velocity in the evaporator suction line is sufficient to move oil along with gas to the compressor. Where equipment location requires vertical risers, line shall be sized to maintain sufficient velocity to lift oil at minimum system loading and corresponding reduction of gas volume. Install a double riser when excess velocity and pressure drop would result from full system loading. Larger riser shall have a trap, of minimum volume, obtained by use of 90- and 45-degree ells. Arrange small riser with inlet close to bottom of horizontal line, and connect to top of upper horizontal line. Do not install valves in risers.
- Q. Provide refrigerant driers, sight glass liquid indicators, and strainers in refrigerant piping in accordance with FS 00-A-374 when not furnished by the manufacturer as part of the equipment. Install driers in liquid line with service valves and valved bypass line the same size as liquid line in which dryer is installed. Size of driers shall be determined by piping and installation of the unit on location. Install dryers of 50 cubic inches and larger vertically with the cover for removing cartridge at the bottom. Install

moisture indicators in the liquid line downstream of the drier. Indicator connections shall be the same size as the liquid line in which it is installed.

- R. Locate strainers close to equipment they are to protect. Provide a strainer in common refrigerant liquid supply to two or more thermal valves in parallel when each thermal valve has a built-in strainer. Install strainers with screen down and in direction of flow as indicated on strainer's body.
- S. Install solenoid valves in horizontal lines with stem vertical and with flow in direction indicated on valve. If not incorporated as integral part of the valve, provide a strainer upstream of the solenoid valve. Provide service valves upstream of the solenoid valve, upstream of the strainer, and downstream of the solenoid valve. Remove the internal parts of the solenoid valve when brazing the valve.

3.3 LOOP EXPANSION JOINTS

- A. Install and guide per manufacturers' installation instructions and Mechanical Contractors Association of America "Guidelines for Quality Piping Installations".
- B. Flexible hose expansion loop return fitting shall be supported to allow movement.
- C. For steam applications, the operating pressure shall be based on burst pressure with an 8 to 1 safety factor.

3.4 WORKMANSHIP

- A. Cut pipes accurately to measurements established at structure. Install pipes without springing or forcing.
- B. Clear windows, doors, and other openings with all pipes and ductwork. Arrange pipes to permit expansion and contractions without misalignment or damage.
- C. During construction all openings in piping and equipment shall be closed with caps or plugs to keep out all foreign matter indicated.
- D. All piping in finished spaces shall be run concealed unless otherwise indicated.

3.5 WELDING

- A. See Section 23 00 10.

3.6 SLEEVES AND PLATES

- A. See Section 23 00 10.

3.7 FLOW METER FITTINGS

- A. Locate and arrange piping, both upstream and downstream of fitting to conform to the manufacturer's published literature.

- B. When flow is measured in horizontal pipe, locate the connection nipples at or slightly above the horizontal centerline of the pipe to minimize the entrance of gases and impurities.
- C. Provide each fitting with an integral tab, or a metal tag or a stainless steel wire, extending outside the pipe covering, and stamp or print in a plainly visible position the manufacturer's name and address; the model number of the meter to which it is to be connected; the name, number or location of the equipment served; the specified rate of flow and the multiplier (including unity, where applicable) to be applied to the meter reading.
- D. Provide fittings with shut-off valves and with quick connecting hose fittings for portable meters.

3.8 TESTS

- A. The following tests shall be conducted by the Contractor and all piping shall be proven tight in the presence of the Architect or his representative. Notify Architect prior to tests. These tests shall be conducted before any insulation is installed and any insulation installed prior to test shall be removed. Provide all equipment and labor required. Tests shall be at least four hours in duration. Piping may be tested in sections as approved by the Architect. Tests shall be specified herein.
- B. All hot water heating (steel) piping shall be hydrostatically tested to 1-1/2 times the system working pressure or a minimum of 100 psig, whichever is greater.
- C. Upon completion of installation of refrigerant piping, test factory- and field-installed refrigerant piping in accordance with ASME B31.5. Use nitrogen or other suitable dry gas for testing. Ensure that test gas is eliminated from the system before charging. Minimum refrigerant leak field test pressure shall be as specified in ASHRAE 15, except that test pressure shall not exceed 150 psig on hermetic compressors unless otherwise specified as a low side test pressure on the equipment nameplate. If leaks are detected at time of installation or during warranty period, remove the entire refrigerant charge from the system, correct leaks, and retest system.
- D. After field charged refrigerant system is found to be without leaks or after leaks have been repaired on field-charged and factory-charged systems, evacuate the system using a reliable gage and a vacuum pump capable of pulling a vacuum of at least one mm Hg absolute. Evacuate system in accordance with the triple-evacuation and blotter method or in accordance with equipment manufacturer's printed instructions and charge system with proper volume of refrigerant.
- E. All pressure piping systems, unless otherwise specified herein, shall be filled with water and thoroughly flushed clean of foreign matter after erection and before connection of equipment.
- F. All centrifugal fans and centrifugal pumps shall be dynamically balanced and certified by an independent testing agency. The agency shall specialize in dynamic balancing of equipment and shall be able to demonstrate experience and expertise in dynamic documentation of all testing, including all test information as well as the certification. These documents shall become permanent records of the facility. The contractor shall

be responsible to perform any alignment corrections and shall not be released of his contractual obligation until all equipment is certified to be dynamically balanced. All equipment requiring re-alignment shall be re-tested and certified. Submit name of testing company to the owner and engineer for approval.

END OF SECTION 23 00 50

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SECTION 23 05 33

HEAT TRACING FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes heat tracing for HVAC piping with the following electric heating cables:
 - 1. Self-regulating, parallel resistance.
 - 2. Control and monitoring modules

1.3 COMMISSIONING

- A. Division 23 will be responsible to carry out the commissioning requirements specified in Section 23 00 10, and 23 08 00.

1.4 SUBMITTALS

- A. Submit shop drawings for all materials specified in this section in accordance with Section 23 00 50.
 - 1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
 - 2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.
 - 3. Include diagrams for power, signal, and control wiring.

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

- A. Subject to compliance with requirements, provide products by one of the following:
 - 1. Chromalox, Inc.
 - 2. Raychem; Tyco Thermal Controls.
 - 3. Thermon Americas Inc.
- B. Comply with IEEE 515.1.
- C. Heating Element: Pair of parallel No. 16 AWG, tinned, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.
- D. Electrical Insulating Jacket: Flame-retardant polyolefin.

- E. Cable Cover: Tinned-copper braid and polyolefin outer jacket with ultraviolet inhibitor.
- F. Maximum Operating Temperature (Power On): 150 deg F.
- G. Maximum Exposure Temperature (Power Off): 185 def F.
- H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- I. The heater shall be:
 - 1. Volts: 120
 - 2. Phase: 1
 - 3. Hertz: 60

2.2 CONTROLS

- A. Local Thermostat with Ground Fault Protection and Alarm Relay.
 - 1. Remote bulb unit with adjustable temperature range set to activate heat trace at 40 deg F.
 - 2. Two-pole contactor switches up to 30 AMP heater loads.
 - 3. Integral 30ma GFEP.
 - 4. Enclosure shall be corrosion-resistant polycarbonate and NEMA 4X rated.
 - 5. The system shall sense ambient temperature in the general area of the traced pipe and turn heat tracing on when outside temperature is below 40 deg F and turn the heat tracing off when outside temperature is above 42 deg F.
 - 6. Remote interface provided via alarm relay. The system shall self test and alarm for no power, ground fault condition, GFEP function test failure, and damaged thermistor.

2.3 ACCESSORIES

- A. Provide cable installation accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.
- B. Warning Labels: Vinyl-based and installed on the thermal insulation weather barrier. In accordance with the NEC, electrically heated pipelines and vessels are to be clearly identified "at frequent intervals along the pipeline or vessel". Caution labels should be placed at 10'-20' intervals or as required by local code.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. The Division 26 contractor shall be responsible for power wiring and terminations between the electrical power system, and the controls. The Division 23 contractor shall be responsible for control wiring and conduit (if required) and the power wiring between the controller and heat trace termination kits. The Division 23 contractor shall provide system layout drawing including cable, control location, sensors, and power connection points. Divisions will be required to coordinate with each other to meet specified installation requirements.
- B. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.
- C. Install Controls per manufacturer's written instruction.
- D. Electric Heating-Cable Installation for Freeze Protection for Piping:
 - 1. Install electric heating cables after piping has been tested and before insulation is installed.
 - 2. Install electric heating cables according to IEEE 515.1.
 - 3. Install insulation over piping with electric cables according to Section 23 07 00 "Mechanical Systems Insulation"
 - 4. Install warning tape on piping insulation where piping is equipped with electric heating cables.
- E. Set field-adjustable switches and circuit-breaker trip ranges by Division 26.

3.3 CONNECTIONS

- A. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
 - 2. Test cables for electrical continuity and insulation integrity before energizing.
 - 3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
- B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.
- C. Cables will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.5 PROTECTION

- A. Protect installed heating cables, including nonheating leads, from damage during construction.
- B. Remove and replace damaged heat-tracing cables.

END OF SECTION 23 05 33

SECTION 23 05 93

TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This section includes all labor and materials necessary to adjust, balance and test performance in accordance with design criteria and the equipment and components of systems included in Division 23 as follows:
 - 1. Air Distribution
 - 2. Water Distribution
 - 3. Equipment Performance
- B. Static pressure duct leakage tests will be performed under another section and shall be witnessed under this section.

1.3 COMMISSIONING

- A. Division 23 will be responsible to carry out the commissioning requirements specified in Division 01 Section 23 00 10, 23 08 00 and other sections.

1.4 QUALIFICATIONS

- A. Work included in this section shall be performed by approved contractor who shall test, adjust, and balance the air and water systems for this project in accordance with NEBB or AABC standard procedures.
- B. All work shall be performed under direct supervision of a qualified engineer. All instruments used shall be accurately calibrated and maintained in good working order. If requested, calibration tests of equipment to be used shall be performed in the presence of the Engineer or Owners Representative.
- C. Qualifications shall include the name of the technician that will be assigned to this project. The technician's qualifications shall be included and shall include successfully completed projects of similar size and complexity, references, and formal training.
- D. If the Contractor fails to submit the name of an acceptable agency within the specified time, the Architect will select a firm to accomplish the work, and the selection shall be binding at no additional cost to the Owner.
- E. All work shall be performed under direct supervision of a qualified engineer. All instruments used shall be accurately calibrated and maintained in good working order.

If requested, calibration tests of equipment to be used shall be performed in the presence of the Engineer.

1.5 TEST REPORT

- A. The balancing agency shall prepare a written report which shall include diagrams and description of procedures together with all recorded test data. The report shall be submitted in bound volumes for a permanent record. Submit four (4) copies of report. A set of contract drawings shall also be submitted. Drawings shall have each air device, flow fitting, pump, fan, and traverse location identified in red ink by a number which shall match identification numbers utilized in the balancing report. Commissioning checklists and functional performance test sheets shall be included in a separate section of final testing, balancing and commissioning report.
- B. Reports shall be submitted in accordance with requirements of Section 01 33 00 Submittal procedures.

1.6 TEST PROCEDURE

- A. Systems may be tested in increments when approved by the Engineer.
- B. When testing and balancing involve the building temperature control systems, cooperate with the temperature control subcontractor to achieve the desired results. All setpoints shall be documented and included with test report.
- C. At the time of the final inspection, recheck in the presence and at the request of the Engineer not to exceed ten percent (10%) of the previously recorded readings from the certified report selected at random from the log by the Engineer.
- D. Permanently mark the settings of valves, dampers, and other adjustment devices so that adjustment can be restored if disturbed at any time. Do not permanently mark devices before final acceptance.
- E. Perform all tests in accordance with NEBB or AABC standard procedures. Any deviation from same must be approved by the Engineer.
- F. Should the basic system or any of its components fail to meet contract requirements, and thereby make the testing and balancing work invalid, notify the Engineer and stop the tests until such time that the failure is corrected.

PART 2 - PRODUCTS

2.1 TESTING INSTRUMENTS

- A. Use instruments of equal or better quality than those described in the technical portions of Associated Air Balance Council National Standards for Testing and Balancing, Heating, Ventilating and Air Conditioning Systems, Fifth Edition, 1989.
- B. Instruments used for balancing air and water systems must have been calibrated within a period of six (6) months prior to balancing. Submit serial numbers, and dates of calibration of all instruments to be used prior to the start of work.

C. Instrumentation shall include, as a minimum, the following items of equipment:

1. Pressure gauges and fittings.
2. Dry bulb and wet bulb thermometers.
3. Contact pyrometer.
4. Portable flow meter and, if required, orifice plates.
5. Pitot tube and manometers.
6. Alnor Velometer with attachments.
7. Amprobe.
8. Tachometer.
9. Data Loggers

PART 3 - EXECUTION

3.1 GENERAL

- A. Within fifteen (15) days of receipt of notice to proceed, review plans and specifications of systems to be tested, and balanced, to confirm that the arrangement, instrumentation and balancing devices will permit the system to be balanced and tested in the manner described in this section and report to the Engineer any devices which need to be added or any phase of the design which needs to be modified to permit the fulfillment of this contract.
- B. Conduct balancing and testing in accordance with technical portions of the Associated Air Balancing Council--"National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems, Fifth Edition, 1989". Test procedures not in accordance or not described in the standards, i.e., variable air volume systems shall be approved by the Engineer in writing.
- C. Provide all labor, testing equipment, and materials required to conduct tests and balance systems,.
- D. System shall be operated at least four (4) hours after stabilized operating conditions have been established before conducting capacity tests. Capacity and performance tests of equipment and systems shall be performed only after balancing is complete.

3.2 AIR DISTRIBUTION SYSTEMS

- A. All air distribution systems including supply, return, outdoor air and exhaust ductwork shall be tested and balanced and commissioned.
- B. Where the system cannot be properly balanced or equipment tested due to system deficiencies such as inability to properly adjust fan speeds, improperly sized motors, excessively noisy equipment, malfunctioning controls, excessively out of balance air distribution system branch runs, and similar item, furnish to the Engineer in writing a list of the deficiencies prior to the submission of the test report.
- C. Make openings in ducts required for pitot tube insertion and seal those openings with snap-in plugs. Neatly remove duct insulation as required for test. Replacement of insulation, after testing is completed, is included under Section 23 07 00.

D. Specific testing and balancing procedures shall include:

1. Test and adjust speed of all air apparatus.
2. Test and record motor voltage and amperage.
3. Make Pitot tube traverse of main ducts and obtain design air quantity at fans.
4. Test and record system static pressures, suction, and discharge as well as pressure drops across each system element; ie, filters, coils, silencers, etc. Test and record static pressure and record settings of variable volume systems at pressure controllers. Record temperature control air pressure setpoints for minimum outside air, and maximum and minimum supply air volumes for all variable air volume systems.
5. Test and adjust systems for design supply, outside, exhaust, and return air quantities.
6. Test and record air entering and leaving conditions at air unit on both heating and cooling modes.
7. Adjust all main and branch ducts for supply, return and exhaust air. Set and "mark" all volume dampers. Identify, test, and adjust each grille, register, and diffuser to within ten percent (10%) of design quantities except as noted below:

For critical areas where differential pressures must be maintained:

For positive zones, supply air shall be balanced within 0 to 10% high and exhaust/return 0 to 10% low. For negative zones, supply air shall be balanced within 0 to 10% low and exhaust/return 0 to 10% high.

8. Verify operation of each room thermostat serving VAV terminal units over full range of heating and cooling to insure proper sequence of control of the VAV operator and reheat coil valve. Record results.
9. Field test maximum and minimum air volumes of all variable air volume terminal units and record final settings. Check factory settings of regulators and controllers before tests. Reset to the scheduled air volumes if required.
10. Verify accuracy of all duct air monitors by duct traverse.
11. Work in conjunction with the ATC Contractor and Engineer to establish maximum and minimum settings on all variable air volume fans.
12. Check operation of variable air volume system controls. Test supply and return fan and outside air volumes by duct traverse at maximum, midpoint, and minimum air volumes to verify that programmed volume differential is maintained.
13. Verify installation of equipment, systems, and related controls and devices. Document on precommissioning checklists.

- E. Witness duct pressure tests as performed under Section 23 33 00. Submit with balancing report test condition and results for each section of duct tested. Include diagrams if required to define tested sections. Submit preliminary test data as soon as possible after testing.

3.3 WATER DISTRIBUTION SYSTEMS

- A. After the fluid piping system, including strainers, have been cleaned and controls are functioning as required under other sections of Division 23, adjust balancing devices installed for this purpose in accordance with the NEBB or AABC technical procedures to obtain the specified fluid flow or heat transfer rate.

- B. Use reading from system flow fittings, when installed, to determine flow quantity. Where fittings are not installed, determine liquid flow by measuring water pressure drop through devices with known Cv or pressure drop at specific flow rates. Use flow meter compatible with the type of fittings installed.
- C. Where liquid flow balancing cannot be accomplished due to system deficiencies such as excessive or lack of pumping head, inadequately sized motors, pressure drops not determinable or similar problems, prepare a list of such deficiencies and the suggested system modifications and furnish to the Engineer in writing and prior to submission of test report for necessary action.
- D. Specific testing and balancing procedures shall include:
 - 1. Check expansion tank for water level and tank pressure. Record pressure.
 - 2. Check all air vents for operation. Completely eliminate air from water systems.
 - 3. Set and adjust all pumps for proper delivery rates. Record all pump nameplate information. Record pump flow, water temperature, inlet and outlet pressures, and motor voltage amps, and rpm.
 - 4. Set and adjust water flow in all piping system branches and risers and record flow.
 - 5. Verify installation of equipment, systems and related controls and devices. Document on pre-commissioning checklists.

3.4 EQUIPMENT PERFORMANCE

- A. Conduct performance tests only after the air and water systems have been balanced and the proper flow rates established.
- B. Test and record capacity of heat transfer equipment including all coils. Air side and water side capacities must agree within five percent (5%) of each other. Include the manufacturer's rated capacity at the test operating conditions with the report. Perform tests where possible at design conditions. If tests are not performed under design conditions, interpolate results to determine capacity at full load operating conditions.
- C. Calculate efficiency of pumps and fans by recognized methods using test data.
- D. Test refrigeration equipment to determine heat extracted from or heat added to the building by the equipment and the heat ejected from the device. Record date, time and outside weather conditions, including ambient dry bulb, wet bulb, wind speed and direction, cloud cover, rain, and any special conditions pertinent to the test.
- E. Perform functional performance tests (FPTS) and document on FPT forms for:
 - 1. VAVs (sample strategy)
 - 2. AHUs
 - 3. Fans
 - 4. Pumps
 - 5. Other equipment and/or systems as required

3.5 COMMISSIONING RESPONSIBILITIES

- A. With respect to HVAC commissioning, the TAB agency shall:
1. Include cost for HVAC commissioning requirements in the quoted price.
 2. Attend commissioning meetings scheduled by the CA prior to, and during, on-site TAB work being done.
 3. Submit proposed TAB procedures to the CA and mechanical engineer for review and acceptance.
 4. Attend the TAB planning meeting scheduled by the CA. Be prepared to discuss the procedures that shall be followed in testing, adjusting and balancing the HVAC system.
 5. At completion of the TAB work, submit the final TAB report to the general contractor or construction manager, with copies to the Owner, CA and mechanical engineer.
 6. Participate in verification of the TAB report by the CA for verification or diagnostic purposes. This will consist of repeating a sample of 10% of the measurements contained in the TAB report as directed by the CA.
 7. Participate in O&M personnel training sessions as scheduled by the CA.

END OF SECTION 23 05 93

SECTION 23 07 00

MECHANICAL SYSTEMS INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and Division 01 specifications, apply to the work specified in this Section.

1.2 SUMMARY

- A. Work included in this section consists of furnishing all labor, equipment, materials and accessories, and performing all operations required, for the correct fabrication and installation of thermal insulation applied to the following piping, equipment, and duct systems, in accordance with applicable project specifications and drawings:

1. Heating systems (steam, steam condensate, hot water) 105°F and up.
2. Cooling systems (chilled water, brine, refrigerant), 0°F to 60°F.
3. Air handling ductwork, shafts, and plenums, to 1200°F.
4. Air conditioning condensate drain piping.
5. Expansion/compression tanks.
6. Air separators.
7. Piping system filtration unit housing.

- B. Work excluded in this Section are the following:

1. Thermal building insulation.
2. Sound absorbing duct lining.

- C. The requirements of Section 23 00 10, Mechanical General Provisions, shall apply to the work specified under this Section.

1.3 DEFINITIONS

- A. The k factor means the number of British thermal units of heat transmitted per (sq. ft.) Fahrenheit temperature difference through a material with flat, parallel sides one inch (1") apart. The material shall be tested and rated according to ASTM Test Method C-177.
- B. The term "Mineral Fiber" as defined above specifications includes fibers manufactured of glass, rock or slag processed from a molten state, with or without binder.
- C. Unless otherwise specified, the term concealed, as used in this specification, shall include all furred spaces, accessible pipe and duct shafts, and spaces above suspended ceilings.
- D. Unless otherwise specified, the word exposed shall refer to all work other than "concealed" work.

1.4 REFERENCES

- A. Thermal insulation materials shall meet the property requirements of one or more of the following specifications as applicable to the specific product or use:
1. American Society for Testing of Materials Specifications:
 - a. ASTM C 533-07: Specification for Calcium Silicate Block and Pipe Thermal Insulation.
 - b. ASTM C 547 "Standard Specification for Mineral Fiber Pipe Insulation"
 - c. ASTM C553 "Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications"
 - d. ASTM C585 "Standard Practice for Inner and Outer Diameters or Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System)"
 - e. ASTM C-591 "Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation"
 - f. ASTM C 612 "Standard Specification for Mineral Fiber Block and Board Thermal Insulation"
 - g. ASTM C 795 "Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel"
 - h. ASTM C 1126-04: Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation.
 - i. ASTM C 1136 "Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation"
 - j. ASTM C 1290 "Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts"
 - k. ASTM G-21 "Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi" (fungi resistance section only)
 - l. ASTM G 22 "Practice for Determining Resistance of Plastics to Bacterial (bacteria resistance section only)

1.5 SYSTEM PERFORMANCE

- A. Insulation materials furnished and installed hereunder should meet the minimum economic insulation thickness requirements of the North American Insulation Manufacturers' Association (NAIMA) to ensure cost-effective energy conservation performance. Alternatively, materials should meet the minimum thickness requirements of Standard 90.1, "Energy Standard for Building Except Low Rise Residential Buildings," of the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE). However, if other factors such as condensation control or personnel protection are to be considered, the selection of the thickness of insulation should satisfy the controlling factor. In no case shall the insulation thickness be less than that specified herein.
- B. Insulation materials furnished and installed hereunder shall meet the fire hazard requirement of any one of the following specifications:
1. American Society of Testing of Materials ASTM E 84
 2. Underwriters' Laboratories, Inc. UL 723
 3. National Fire Protection Association NFPA 255

1.6 FIRE RESISTANCE

- A. Except for materials which are subsequently exempted, all materials used as part of the thermal insulation shall have a fire hazard rating not to exceed twenty five (25) for flame spread and fifty (50) for fuel contributed and smoke developed.
- B. Test factory assembled materials as assemblies.
- C. Determine ratings by the Standard Method of Test for Surface Burning Characteristics of Building Materials, ASTM E-84 or NFPA No. 255.
- D. The following will be required to establish that fire hazard ratings for materials proposed for use do not exceed those specified: (1) label or listing by Underwriter's Laboratories, Inc., (2) certified test report from an approved testing laboratory.
- E. The following materials are exempt from the foregoing Fire Resistant Rating:
 - 1. Jackets of canvas, PVC and nylon.
 - 2. Polyurethane, polystyrene, cork and flexible, closed-cellular insulation.
 - 3. Nylon anchors for securing insulation to ducts and equipment.
 - 4. Factory premolded one (1) piece PVC fitting and valve covers.

1.7 QUALIFICATIONS

- A. Materials submitted shall be standard products of a manufacturer who has been engaged in the production of the products for not less than three (3) years.
- B. The installing sub-contractor shall have at least five (5) years of successful installation experience on projects with similar insulation products.

1.8 QUALITY ASSURANCE

- A. Insulation materials and accessories furnished and installed hereunder shall, where required, be accompanied by manufacturers' current submittal or data sheets showing compliance with applicable specifications listed in Section 1.4 above.
- B. Insulation materials and accessories shall be installed in a workmanlike manner by skilled and experienced workers who are regularly engaged in commercial insulation work.

1.9 SUBMITTALS

- A. Provide shop drawings in accordance with Section 23 00 10 and the General Requirements which shall include all insulation, jackets, finishes, corner beads, etc. Shop drawings shall additionally describe each system or component to be insulated, insulation type and thickness, and method of installation.

1.10 DELIVERY AND STORAGE OF MATERIALS

- A. All of the insulation materials and accessories covered by this specification shall be delivered to the job site and stored in a safe, dry place with appropriate labels and/or other product identification.

- B. The contractor shall use whatever means are necessary to protect the insulation materials and accessories before, during, and after installation. No insulation material shall be installed that has become damaged in any way. The contractor shall also use all means necessary to protect work and materials installed by other trades.
- C. If any insulation material has become wet because of transit or job site exposure to moisture or water, the contractor shall not install such material, and shall remove it from the job site. An exception may be allowed in cases where the contractor is able to demonstrate that wet insulation when fully dried out (either before installation, or afterward following exposure to system operating temperatures) will provide installed performance that is equivalent in all respects to new, completely dry insulation. In such cases, consult the insulation manufacturer for technical assistance.

1.11 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 00 50 and Section 23 00 10.
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.12 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All insulating materials, including adhesives, jackets and coatings, to be used on the project must be delivered to the building in the manufacturer's unopened container and must bear the manufacturer, brand and description of material.
- B. After the necessary tests have been conducted to prove the water and air systems tight, all piping, ductwork and equipment to be insulated shall be thoroughly cleaned and then covered. Insulation materials shall be the product of Owens Corning, Knauf, Manville or Armstrong equal to the products specified herein.
- C. Molded pipe insulations shall be manufactured to meet ASTM C 585 and ASTM C 547.
- D. Light density glass fiber duct wrap shall be manufactured to meet the requirements of ASTM C 1290.
- E. Heavy density glass fiber duct board shall be manufactured to meet the requirements of ASTM C 612.

2.2 TYPES OF INSULATION:

- A. Refer to insulation type schedule on drawings.

2.3 ADHESIVES, SEALERS AND COATINGS

- A. Provide all adhesives, sealers, vapor barrier coatings etc., compatible with the material to which they are applied. They shall not corrode, soften or otherwise attack such material in either the wet or dry state and must be suitable for the service temperatures.
- B. Any cement, sealer or coating used shall be resistant to vermin and mold and shall be durable. It shall not discolor on aging; and where applied on the final surface of the insulation, it shall be light in color and be capable of being painted.
- C. Adhesives, coatings and compounds shall be equal to the following:
 - 1. Vapor barrier adhesive for sealing joints on pipe and duct insulation - Foster 85-75.
 - 2. Adhesive for installing duct insulation - Foster 85-20 and 81-91.
 - 3. Insulating cement - Owens Corning No. 110

2.4 FITTINGS AND VALVE COVERS

- A. Pipe fittings and valves shall be insulated with Owens Corning PVC premolded one (1) piece PVC insulated fitting cover and factory precut insulation. Fittings shall have edges of one (1) piece cover sealed with Owens Corning vapor barrier pressure sensitive tape.

2.5 METALLIC COMPONENTS

- A. Staples shall be outward clinching type of Type 304 or Type 316 stainless steel.
- B. Bands shall be galvanized steel, aluminum, brass, or nickel-copper alloy, of three-quarter inch (3/4") nominal width. The band thickness, exclusive of coating, shall be not less than five thousandths inch (0.005") for steel and nickel copper alloy, seven thousandths inch (0.007") for aluminum, and one hundredth inch (0.01") for brass.
- C. Wire shall be 14-gauge, nickel-copper alloy or copper clad steel, or 16-gauge, soft annealed, galvanized steel.
- D. Wire netting used for exposed surfaces of insulation that is to be cement finished shall be 22-gauge, one-inch (1") galvanized mesh, with continuous 26-gauge galvanized steel corner beads having two and one-half inch (2-1/2") wings.
- E. Protect external corners on insulation of ducts and equipment exposed in occupied spaces by corner beads two inches (2") by aluminum adhered to heavy duty Kraft paper.
- F. All exterior piping shall be additionally covered with a sixteen mil (16 mil) (0.4mm) embossed aluminum or stainless steel weatherproof jacket. Jacketing shall be

Childers Lock-on type with factory applied poly kraft moisture barrier. Jackets are to be fabricated with continuous Z-lock on the longitudinal seam and sections shall be joined with factory fabricated butt strap and sealant. Fitting shall be insulated and weatherproofed using similar materials.

- G. Where indicated, all piping shall be covered with UV resistant Owens Corning or Zeston PVC jacketing. Installation shall be in accordance with the manufacturer's limitation with regard to surface temperature and thermal expansion. Fittings shall be insulation as prescribed above, jacketed with pre-formed fittings covers matching the outer jacketing.

2.6 INSULATION SCHEDULE:

- A. Refer to insulation schedule on drawings.
- B. Insulation thickness may be reduced on ducts with internal lining in an amount equal to the thickness of the lining. Refer to drawings for internal lining locations.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL

- A. All insulation shall be installed by skilled workmen regularly engaged in this type of work.
- B. Insulation shall be continuous at all hangers, sleeves and openings. Vapor seals shall be provided for all cold surfaces and shall be continuous.
- C. Arrange to permit expansion and contraction without causing damage to insulation or surface.

- D. Actual insulation thickness must be at least equal to the minimum specified in the schedule. Where the manufacturers' rated or nominal thickness is less than the minimum specified, a thicker material or more layers will be requested so that the stated minimum thickness will be attained or exceeded.
- E. Install insulation materials in a first class manner with smooth and even surfaces. Scrap pieces of insulation shall not be used where a full length section will fit.
- F. Unless otherwise specified herein, the application of all insulation materials, accessories and finishes shall be in accordance with the manufacturer's published recommendations.
- G. Insulation materials shall not be applied until all surfaces to be covered are clean and dry; all foreign material, such as rust, scale, dirt, etc., has been removed; and, where specified, surfaces have been painted. Insulation shall be clean and dry when installed and during the application of any finish. The insulation on pipe fittings, valves and pipe joints shall not be installed before the piping is tested and approved.
- H. Omit insulation on the following unless directed otherwise:
 - 1. Traps and pressure reducing valves, relief piping from safety valves, and unions, flanges and expansion joints on hot water heating system.
 - 2. All fuel oil piping.
 - 3. Exposed ducts in air conditioned spaces.
- I. Replace and repair insulation disturbed by testing and balancing procedures.

3.4 PIPE INSULATION

- A. High density pipe saddles shall be provided at all points of support as hereinbefore specified in Section 23 00 10.
- B. Insulate all valves and strainers. Use premolded covers and factory precut insulation where applicable. Unions and flanges shall not be insulated except on cold service.
- C. Insulate valves up to and including bonnets, except for cold water valves which shall be insulated over packing nuts in a manner to permit removal for adjustment and repacking.
- D. Insulate strainers in a manner to permit removal of the basket without disturbing the insulation of the strainer. Obtain Engineer's approval of installation method.
- E. Application - Types I & XV Insulation
 - 1. Insulate all pipes in a neat and workmanlike manner. Seal all longitudinal laps of jackets and staple every six inches (6"). Where the piping operates below ambient temperature, the staples shall be coated with vapor barrier adhesive. All butt joints shall be wrapped with a three inch (3") minimum wide strip of jacketing material securely sealed in place.

2. Insulate valves and fittings with pre-cut blanket type fiberglass insulation and PVC covers as specified. Insulation shall be of the same thickness as that on adjoining pipe. The ends of the insulation shall be tucked snugly into the throat of the fitting and the edges adjacent to the pipe covering tufted and tucked in, fully insulating the pipe fitting. The one (1) piece PVC fitting cover shall then be secured by stapling, tack fastening, banding or taping the ends to the adjacent pipe covering. Chilled water supply and return piping and cold water systems piping shall be insulated as above and have all seam edges of the cover sealed with ZESTON vapor barrier adhesive mastic. The circumferential edges of cover shall be color matching tape. The tape shall extend over the adjacent pipe insulation and overlap itself at least two inches (2") on the downward side.
3. Where fittings are operating above ambient they may, in lieu of the preceding paragraph, be covered with a three hour (3 hr.), hydraulic setting, combination insulating and finishing cement having k factor not greater than 0.87 at a mean temperature of two hundred degrees Fahrenheit (200° F). The thickness of this cement shall be such that the surface is substantially flush with the pipe covering. Where the insulation terminates at a fitting that is not covered, the end of the insulation shall be beveled off with this same cement. All fittings insulated in this manner shall be covered by a fabric jacket as specified, which shall be cemented down with lagging adhesive.
4. For all type XV applications, install per manufacturer's recommendations and provide a [0.01" type 304 stainless steel jacket] [Zeston UV resistant PVC jacket] [0.02" type T-303 aluminum jacket with a factory applied protective inner layer].
5. Where expansion joints are required to be insulated, they shall be covered with readily removable sections of insulation of same composition and thickness as provided for adjacent piping.

F. Application - Type II Insulation

1. The material shall be slit lengthwise to permit installation or slipped over pipe before connections are made.
2. All joints and seams must be thoroughly bonded, both mechanically and hermetically, by the adhesive recommended by the insulation manufacturer. Also, the manufacturer's recommendations shall be followed as to the adhesive to use where the insulation needs bonding to metal or other material used for any surface treatment where a finish coat of paint is required.
3. All penetrations of the insulation must be thoroughly sealed so that the insulation itself will form a complete vapor barrier. Wherever the insulation terminates, the edges shall be sealed to the metal.

3.5 DUCT INSULATION

- A. Provide accessories as required to prevent distortion and sagging of duct insulation. Provide welded pins, adhesive clips and wire ties as recommended by the manufacturer and directed by the Engineer.

- B. Insulation shall cover all standing seams and metal surface. Provide corner beading on all exposed ducts.
- C. Staples shall be sealed to maintain vapor barrier.
- D. Neatly cut insulation at dampers, temperature control sensors, and controllers. Butter exposed edges with approved mastic coating. Extend insulation to cover pipe return bends for air terminal unit reheat coils.
- E. Application - Type IV Insulation:
 - 1. Insulation shall be cut slightly longer than perimeter of duct to insure full thickness of corners. All insulation shall be applied with edges tightly fastened with staples. Tape the stitched seam with three inch (3") wide pressure sensitive tape. The insulation shall be additionally secured to the bottom of all square ducts eighteen inches (18") or wider by means of welded pins and speed clips. The protruding ends of the pins shall be cut off flush after the speed clips have been applied. The vapor barrier facing shall be thoroughly sealed where the pins have pierced through with a tape of the same material by applying a vapor barrier adhesive to both surfaces as recommended by the manufacturer.
 - 2. All joints and penetrations of the vapor barrier shall be sealed with three inch (3") pressure sensitive tape. All cuts or tears shall be sealed with strips of the aluminum foil tape.
- F. Application - Type V Insulation:
 - 1. All insulation shall be applied with edges tightly butted. Insulation shall be impaled on stick clips or pins welded to the duct and secured with speed clips. Spacing of pins shall be as required to hold insulation firmly in place but not less than one (1) pin per square foot (FT²), and pins shall be placed within three inches (3") of each corner of insulation. All joints and penetrations of the vapor barrier shall be sealed with a three inch (3") wide strip of the same material, applied with Foster 85-75, or to both surfaces as recommended by the adhesive manufacturer.
 - 2. If, through space or size restriction or other causes, the welded pin method is impossible, the insulation shall be secured to the duct with adhesive such as Foster 81-91 or equal. The adhesive shall cover the entire surface of the sheet metal when applied to underside of horizontal duct but may be applied in strips or spots for application to top and sides with a minimum of fifty percent (50%) coverage.
- G. Application – Type XIII Insulation
 - 1. Apply a brush coat of manufacturer's recommended adhesive to dry, clean, metal surface covering an area equal to the size of one (1) sheet. Apply a brush coat of adhesive to the back of the sheet. Once the adhesive is tacky, position the sheet so that the edges overlap the previously installed sheets by one eighth inch (1/8"). Apply pressure to adhere sheet. Compress butt edges into place.

Spread joints and coat with adhesive. Apply adhesive to the butt edges of the insulation.

2. Apply manufacturer's recommended seal tape to all joints and exposed edges. Finish by applying even pressure using a roller.

H. Application - Type XIV insulation

1. Insulation shall be applied as a single-layer system applied directly on to the duct surface.
2. Cut the insulation to a length sufficient to wrap around the duct and provide a minimum 3" perimeter overlap. Cut the adjacent piece of insulation long enough to wrap around the duct circumference plus a 3" perimeter overlap. It shall be installed with a minimum 3" longitudinal overlap on to the previously installed piece. Seal all cut edges and joints with aluminum foil tape.
3. Stainless steel banding shall be used to attach the material to the duct, placing the banding 1 1/2" from the blanket edge and approximately 8" on center. Tighten banding to firmly hold the wrap system in place, but not so tight as to cut or damage the blanket.
4. Stainless steel insulation pins may be used as an alternate attachment to stainless steel banding. When only pins and no bands are used, the pins must be attached to the duct surface on all four sides. Pin rows shall be spaced 9 1/2" down the duct length. Pin spacing across the width of the duct top and bottom surface shall be 1 1/2" from the duct edge and 10 1/2" on center. Vertical pin spacing on the duct sides shall be 12" on center.
5. For ducts with spans greater than 24" wide, 12-gauge steel insulation pins shall be welded on the bottom of horizontal duct surfaces and on the outside of vertical duct rises. Insulation pins shall be placed in columns 10 1/2" on center and 1 1/2" from each duct edge and spaced 9 1/2" apart down the duct length. Impale insulation over the pins and hold in place with speed clips (washers) to keep the system from sagging. Exposed ends of pins shall be bent over to eliminate safety hazards. Place steel banding 1 1/2" from blanket edge and maximum 10 1/2" on center.
6. Horizontal duct support assemblies do not require Firetemp SL-2.0 insulation when constructed using a minimum 1/2" diameter all-thread steel rod and 2" x 2" x 1/4" steel angle spaced a maximum 60" on center along the length of the duct. A minimum clearance of 2" is required between the insulated duct and the steel rod. For all other duct support configurations, a single layer of Firetemp SL-2.0 Duct Insulation is required on all components. Utilize a minimum 3" overlap (approximately a one quarter turn) on all joints.
7. Insulate access doors in accordance with manufacturer's recommendations to maintain fire rating.

3.6 EQUIPMENT INSULATION:

- A. Cut or score insulation to fit shape and contour of equipment. Stagger all joints.
- B. Provide permanently fastened angles or plates, where required to support insulation.
- C. Do not cover nameplates. Cut back the insulation and line edges with 26-gauge galvanized steel.
- D. Application - Type VI & IX Insulation
 - 1. Insulation shall be applied with staggered joints firmly butted and joined. The insulation shall be held in place by steel bands. Bands shall be spaced on not over twelve inch (12") centers. All joints and voids shall be filled with cement, well trowelled into openings. Apply over the insulation surface one inch (1") galvanized wire netting laced together at all edges and wired to the steel bands with 16-gauge soft annealed wire. Over this shall be applied a one-half inch (1/2") thick layer of insulating cement applied in two (2) layers. Install metal corner beads at all corners and edges to provide a permanent installation.
- E. Application - Type VII Insulation
 - 1. Apply a brush coat of manufacturer's recommended adhesive to dry, clean metal surface covering an area equal to the size of one (1) sheet. Apply a brush coat of adhesive to the back of the sheet, except for a one-half (1/2") wide border around the edges. After adhesive on metal surface and sheet has dried to a non-tacky state, position sheet so that the edges overlap the previously installed sheets by one eighth inch (1/8"). Apply light pressure to adhere a spot in the center of the sheet only and compress butt edges into place. Spread joints and coat with adhesive.
- F. Application - Type VIII Insulation
 - 1. Apply a brush coat of manufacturer's recommended adhesive to dry, clean three-quarter inch (3/4") high v-rib, stand-off expanded metal lath to provide an air space between the covered surface and insulation, covering an area equal to the size of one (1) sheet. Apply a brush coat of adhesive to the back of the sheet, except for a one-half inch (1/2") wide border around the edges. After adhesive on metal ribs and sheet has dried to a non-tacky state, position sheet so that the edges overlap the previously installed sheets by one eighth inch (1/8"). Apply light pressure to adhere a spot in the center of the sheet only and compress butt edges into place. Spread joints and coat with adhesive.

3.7 FINISHES

- A. All pipes exposed to the weather shall be covered with aluminum jacket minimum 0.016 inch thick kept in place with aluminum bands 12 inches on center. Longitudinal seams shall be on underside of pipe and horizontal joints shall be lapped 3 inches with aluminum bands at edge of overlap.

END OF SECTION 23 07 00

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SECTION 23 08 00

COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. The contractor is responsible for commissioning the systems and components in this section.
- B. The commissioning process requirements are outlined in the related sections listed below. Contractor is responsible for complying with all requirements listed therein.

1.3 RELATED SECTION

- A. Section 01 91 13 "General Commissioning Requirements" for general commissioning process requirements.

END OF SECTION 23 08 00

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SECTION 23 09 00

INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
- B. Related Sections include the following:
 - 1. Section 23 00 50 HVAC Basic Materials and Methods for measuring equipment that relates to this Section.

1.3 DESCRIPTION OF WORK.

- A. The building automation system (BAS) defined in this specification shall interface with Delaware State Network and shall utilize the BACnet communication requirements as defined by ASHRAE/ANSI 135 (current version and addendum) for all communication.
- B. Contractor shall furnish and install a building automation system (BAS) using a vendor currently listed on the state's Building Automation System contract. The new BAS shall utilize electronic sensing, microprocessor-based digital control, and electronic actuation of dampers and valves to perform control sequences and functions specified. The BAS for this project will generally consist of monitoring and control of systems listed below and indicated on the drawings. Reference also control drawings, sequences of operation and points lists.
- C. Subject to the detailed requirements provided throughout the specifications, the BAS and digital control and communications components installed, as work of this contract shall be an integrated distributed processing system utilizing BACnet. System components shall communicate using native BACnet in accordance with ASHRAE Standard 135 and current addenda and annexes, including all workstations, all building controllers, and all application specific controllers. Gateways to other communication protocols are not acceptable.

1.4 DEFINITIONS

- A. DDC: Direct digital control.
- B. I/O: Input/output.
- C. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.
- D. MS/TP: Master slave/token passing.
- E. PC: Personal computer.
- F. PID: Proportional plus integral plus derivative.
- G. RTD: Resistance temperature detector.

1.5 SYSTEM PERFORMANCE

- A. Comply with the following performance requirements:
 - 1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
 - 2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
 - 3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
 - 4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
 - 5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
 - 6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
 - 7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
 - 8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
 - a. Water Temperature: Plus or minus 1 deg F.
 - b. Water Flow: Plus or minus 5 percent of full scale.
 - c. Water Pressure: Plus or minus 2 percent of full scale.
 - d. Space Temperature: Plus or minus 1 deg F.
 - e. Ducted Air Temperature: Plus or minus 1 deg F.
 - f. Outside Air Temperature: Plus or minus 2 deg F.
 - g. Dew Point Temperature: Plus or minus 3 deg F.
 - h. Temperature Differential: Plus or minus 0.25 deg F.
 - i. Relative Humidity: Plus or minus 5 percent.
 - j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
 - k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
 - l. Airflow (Terminal): Plus or minus 10 percent of full scale.

- m. Air Pressure (Space): Plus or minus 0.01-inch wg.
- n. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
- o. Carbon Monoxide: Plus or minus 5 percent of reading.
- p. Carbon Dioxide: Plus or minus 50 ppm.
- q. Electrical: Plus or minus 5 percent of reading.

1.6 SEQUENCE OF OPERATION

- A. Refer to drawings for sequence of operation.

1.7 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
 - 1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
 - 2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
 - 3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
 - 2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
 - 3. Wiring Diagrams: Power, signal, and control wiring.
 - 4. Details of control panel faces, including controls, instruments, and labeling.
 - 5. Written description of sequence of operation.
 - 6. Schedule of dampers including size, leakage, and flow characteristics.
 - 7. Schedule of valves including flow characteristics.
 - 8. DDC System Hardware:
 - a. Wiring diagrams for control units with termination numbers.
 - b. Schematic diagrams and floor plans for field sensors and control hardware.
 - c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.

9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
 10. Controlled Systems:
 - a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
 - b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
 - c. Written description of sequence of operation including schematic diagram.
 - d. Points list.
- C. Samples for Verification: For each color required, of each type of thermostat or sensor cover.

1.8 INFORMATIONAL SUBMITTALS

- A. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.
- B. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with BACnet.
- C. Qualification Data: For Installer and manufacturer.
- D. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.
- E. Field quality-control test reports.

1.9 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
 1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
 2. Interconnection wiring diagrams with identified and numbered system components and devices.
 3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
 4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
 5. Calibration records and list of set points.
- B. Software and Firmware Operational Documentation: Include the following:
 1. Software operating and upgrade manuals.

2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.
5. Software license required by and installed for DDC workstations and control systems.

C. Framed Control Drawings:

1. Laminated control drawings including system control schematics, sequences of operation and panel termination drawings, shall be provided in panels for major pieces of equipment. Terminal unit drawings shall be located in the central plant equipment panel or mechanical room panel.

1.10 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Maintenance Materials: One thermostat adjusting key(s).

1.11 QUALITY ASSURANCE

- A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.12 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
- B. System Software: Update to latest version of software at Project completion.

1.13 COORDINATION

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- B. Coordinate equipment with Section 28 31 11 "Digital, Addressable Fire-Alarm System" and Section 28 31 12 "Zoned (DC Loop) Fire-Alarm System" to achieve compatibility with equipment that interfaces with that system.

- C. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.
- D. Coordinate equipment with Section 26 09 13 "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.
- E. Coordinate equipment with Section 26 24 16 "Panelboards" to achieve compatibility with starter coils and annunciation devices.

1.14 WARRANTY MAINTENANCE

- A. Contractor shall warrant all products and labor for a period of Two Years after Substantial Completion.
- B. The State reserves the right to make changes to the BAS during the warranty period. Such changes do not constitute a waiver of warranty. The Contractor shall warrant parts and installation work regardless of any such changes made by the State, unless the Contractor provides clear and convincing evidence that a specific problem is the result of such changes to the BAS.
- C. At no cost to the State, during the warranty period, the Contractor shall provide maintenance services for software and hardware components as specified below:
 - 1. Maintenance services shall be provided for all devices and hardware specified in this section. Service all equipment per the manufacturer's recommendations. All devices shall be calibrated within the last month of the warranty period.
 - 2. Emergency Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would result in property damage or loss of comfort control shall be corrected and repaired following notification by the State to the Contractor.
 - a. Response by telephone to any request for service shall be provided within two (2) hours of the State's initial telephone request for service.
 - b. In the event that the malfunction, failure, or defect is not corrected through the telephonic communication, at least one (1) hardware and software technician, trained in the system to be serviced, shall be dispatched to the State's site within eight (8) hours of the State's initial telephone request for such services, as specified.
 - 3. Normal Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would not result in property damage or loss of comfort control shall be corrected and repaired following telephonic notification by the State to the Contractor.
 - a. Response by telephone to any request for service shall be provided within eight (8) working hours (contractor specified 40 hr per week normal working period) of the State's initial telephone request for service.
 - b. In the event that the malfunction, failure, or defect is not corrected through the telephonic communication, at least one (1) hardware and software technician, trained in the system to be serviced, shall be dispatched to the State's site within three (3) working days of the State's initial telephone request for such services, as specified.
 - 4. Telephonic Request for Service: Contractor shall specify a maximum of three telephone numbers for The State to call in the event of a need for service. At

least one of the lines shall be attended at any given time at all times. Alternatively, pagers can be used for technicians trained in system to be serviced. One of the three paged technicians shall respond to every call within 15 minutes.

5. Technical Support: Contractor shall provide technical support by telephone throughout the warranty period.
6. Preventive maintenance shall be provided throughout the warranty period in accordance with the hardware component manufacturer's requirements.

D. Licensing

1. Include licensing for all software packages at all required workstations.
2. All operator interface, programming environment, networking, database management and any other software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be licensed and provided to the State.
3. All BAS software should be available on CSS(s) provided, and on all Portable Operator Terminals. All software keys to provide all rights shall be installed on CSS. At least 2 sets of media (CD or DVD) shall be provided with backup software and configurations for all software provided, so that the State may reinstall any software as necessary
4. Provide licensing and original software media for each device. Include all BAS software licenses and all required third party software licenses.
5. Upgrade all software packages to the release (version) in effect at the end of the Warranty Period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 CONTROL SYSTEM

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Automated Logic by Radius Systems
 2. Johnson Controls by Modern Controls
- B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.

- C. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.
- D. Remote Data Access: The system shall support the following methods of remote access to the building data:
 - 1. Browser-based access: A remote user using a standard browser shall be able to access all control system facilities and graphics with proper authentication. The State shall maintain continuous network connection. The following paradigms are acceptable for browser-based access:
 - a. Native Internet-based user interface (HTML, Java, XML, etc.) via a standard freely distributed web browser that does not require a Windows client software installation.

2.3 DDC EQUIPMENT

- A. Operator Workstation: One PC-based microcomputer(s) with minimum configuration as follows:
 - 1. Motherboard: With 8 integrated USB 2.0 ports, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring.
 - 2. Processor: Intel Xeon, 3.3 GHz.
 - 3. Random-Access Memory: 4 GB.
 - 4. Graphics: Video adapter, minimum 1600 x 1200 pixels, 256-MB video memory, with TV out.
 - 5. Monitor: 19 inches, LCD color.
 - 6. Keyboard: QWERTY, 105 keys in ergonomic shape.
 - 7. Hard-Disk Drive: 80 GB.
 - 8. CD-ROM Read/Write Drive: 48x24x48.
 - 9. Mouse: Three button, optical.
 - 10. Uninterruptible Power Supply: 2 kVa.
 - 11. Operating System: Microsoft Windows 7 Professional with high-speed Internet access.
 - a. ASHRAE 135 Compliance: Workstation shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
 - b. LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA 709.1 datalink/physical layer protocol.
 - 12. Printer: Color, ink-jet type as follows:
 - a. Print Head: 4800 x 1200 dpi optimized color resolution.
 - b. Paper Handling: Minimum of 100 sheets.
 - c. Print Speed: Minimum of 17 ppm in black and 12 ppm in color.

13. Application Software:

- a. I/O capability from operator station.
- b. System security for each operator via software password and access levels.
- c. Automatic system diagnostics; monitor system and report failures.
- d. Database creation and support.
- e. Automatic and manual database save and restore.
- f. Dynamic color graphic displays with up to 10 screen displays at once.
- g. Custom graphics generation and graphics library of HVAC equipment and symbols.
- h. Alarm processing, messages, and reactions.
- i. Trend logs retrievable in spreadsheets and database programs.
- j. Alarm and event processing.
- k. Object and property status and control.
- l. Automatic restart of field equipment on restoration of power.
- m. Data collection, reports, and logs. Include standard reports for the following:
 - 1) Current values of all objects.
 - 2) Current alarm summary.
 - 3) Disabled objects.
 - 4) Alarm lockout objects.
 - 5) Logs.
- n. Custom report development.
- o. Utility and weather reports.
- p. Workstation application editors for controllers and schedules.
- q. Maintenance management.

14. Custom Application Software:

- a. English language oriented.
- b. Full-screen character editor/programming environment.
- c. Allow development of independently executing program modules with debugging/simulation capability.
- d. Support conditional statements.
- e. Support floating-point arithmetic with mathematic functions.
- f. Contains predefined time variables.

B. Diagnostic Terminal Unit: Portable notebook-style, PC-based microcomputer terminal capable of accessing system data by connecting to system network with minimum configuration as follows:

- 1. System: With one integrated USB 2.0 port, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring.
- 2. Processor: Intel Core i7, 3 GHz.
- 3. Random-Access Memory: 4 GB.
- 4. Graphics: Video adapter, minimum 1024 x 768 pixels, 256-MB video memory.
- 5. Monitor: 17 inches, LCD color.
- 6. Keyboard: QWERTY 105 keys in ergonomic shape.

7. Hard-Disk Drive: 80 GB.
 8. CD-ROM Read/Write Drive: 48x24x48.
 9. Pointing Device: Touch pad or other internal device.
- C. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse I/O.
 - c. Monitoring, controlling, or addressing data points.
 - d. Software applications, scheduling, and alarm processing.
 - e. Testing and developing control algorithms without disrupting field hardware and controlled environment.
 3. Standard Application Programs:
 - a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
 - b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
 - c. Chiller Control Programs: Control function of condenser-water reset, chilled-water reset, and equipment sequencing.
 - d. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
 - e. Remote communications.
 - f. Maintenance management.
 - g. Units of Measure: Inch-pound and SI (metric).
 4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
 5. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
 6. LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA 709.1 datalink/physical layer protocol.
- D. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.

2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse I/O.
 - c. Monitoring, controlling, or addressing data points.
 3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
 4. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
 5. LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA 709.1 datalink/physical layer protocol.
- E. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
1. Binary Inputs: Allow monitoring of on-off signals without external power.
 2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
 3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
 4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
 5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
 6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
 7. Universal I/Os: Provide software selectable binary or analog outputs.
- F. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
1. Output ripple of 5.0 mV maximum peak to peak.
 2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
 3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.
- G. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
1. Minimum dielectric strength of 1000 V.
 2. Maximum response time of 10 nanoseconds.
 3. Minimum transverse-mode noise attenuation of 65 dB.
 4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.4 UNITARY CONTROLLERS

- A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
 - 1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
 - 2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.
 - 3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.
 - 4. LonWorks Compliance: Communicate using EIA/CEA 709.1 datalink/physical layer protocol using LonTalk protocol.
 - 5. Enclosure: Dustproof rated for operation at 32 to 120 deg F.
 - 6. Enclosure: Waterproof rated for operation at 40 to 150 deg F.

2.5 ALARM PANELS

- A. Unitized cabinet with suitable brackets for wall or floor mounting. Fabricate of 0.06-inch-thick, furniture-quality steel or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish. Provide common keying for all panels.
- B. Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted on hinged cover.
 - 1. Alarm Condition: Indicating light flashes and horn sounds.
 - 2. Acknowledge Switch: Horn is silent and indicating light is steady.
 - 3. Second Alarm: Horn sounds and indicating light is steady.
 - 4. Alarm Condition Cleared: System is reset and indicating light is extinguished.
 - 5. Contacts in alarm panel allow remote monitoring by independent alarm company.

2.6 ANALOG CONTROLLERS

- A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.
- B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F, and single- or double-pole contacts.

- C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.
 - 1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.
- D. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.
- E. Receiver Controllers: Single- or multiple-input models with control-point adjustment, direct or reverse acting with mechanical set-point adjustment with locking device, proportional band adjustment, authority adjustment, and proportional control mode.
 - 1. Remote-control-point adjustment shall be plus or minus 20 percent of sensor span, input signal of 3 to 13 psig.
 - 2. Proportional band shall extend from 2 to 20 percent for 5 psig.
 - 3. Authority shall be 20 to 200 percent.
 - 4. Air-supply pressure of 18 psig, input signal of 3 to 15 psig, and output signal of zero to supply pressure.
 - 5. Gages: 2-1/2 inches in diameter, 2.5 percent wide-scale accuracy, and range to match transmitter input or output pressure.

2.7 ELECTRONIC SENSORS

- A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
- B. Thermistor Temperature Sensors and Transmitters:
 - 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. BEC Controls Corporation.
 - b. Ebtron, Inc.
 - c. Heat-Timer Corporation.
 - d. I.T.M. Instruments Inc.
 - e. MAMAC Systems, Inc.
 - f. Paragon Controls, Inc.
 - g. RDF Corporation.
 - h. Veris Industries.
 - 2. Accuracy: Plus or minus 0.5 deg F at calibration point.
 - 3. Wire: Twisted, shielded-pair cable.
 - 4. Insertion Elements in Ducts: Single point, 18 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft..

5. Averaging Elements in Ducts: 72 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft..
6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.
7. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - a. Set-Point Adjustment: Concealed or Exposed per client preference
 - b. Set-Point Indication: Concealed or Exposed per client preference
 - c. Thermometer: Concealed.
 - d. Color: Facility Standard
 - e. Orientation: Vertical.
8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

C. RTDs and Transmitters:

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. BEC Controls Corporation.
 - b. MAMAC Systems, Inc.
 - c. Paragon Controls, Inc.
 - d. RDF Corporation.
 - e. Veris Industries.
2. Accuracy: Plus or minus 0.2 percent at calibration point.
3. Wire: Twisted, shielded-pair cable.
4. Insertion Elements in Ducts: Single point, 18 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft..
5. Averaging Elements in Ducts: 24 inches long, rigid; use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required.
6. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
7. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - a. Set-Point Adjustment: Exposed.
 - b. Set-Point Indication: Exposed.
 - c. Thermometer: Concealed.
 - d. Color: Facility Standard
 - e. Orientation: Vertical.
8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

D. Humidity Sensors: Bulk polymer sensor element.

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. BEC Controls Corporation.
 - b. General Eastern Instruments.
 - c. MAMAC Systems, Inc.
 - d. ROTRONIC Instrument Corp.
 - e. TCS/Basys Controls.
 - f. Vaisala.
 - g. Veris Industries.
2. Accuracy: 2 percent full range with linear output.
3. Room Sensor Range: 20 to 80 percent relative humidity.
4. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - a. Set-Point Adjustment: Concealed or Exposed per client preference
 - b. Set-Point Indication: Concealed or Exposed per client preference
 - c. Thermometer: Concealed.
 - d. Color: Facility Standard
 - e. Orientation: Vertical.
5. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
6. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of minus 22 to plus 185 deg F.
7. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

E. Pressure Transmitters/Transducers:

1. 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. BEC Controls Corporation.
 - b. General Eastern Instruments.
 - c. MAMAC Systems, Inc.
 - d. Paragon Controls, Inc.
 - e. ROTRONIC Instrument Corp.
 - f. TCS/Basys Controls.
 - g. Vaisala.
 - h. Veris Industries.
2. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
 - a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
 - b. Output: 4 to 20 mA.
 - c. Building Static-Pressure Range: 0- to 0.25-inch wg.

d. Duct Static-Pressure Range: 0- to 5-inch wg.

3. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.
4. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.
5. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
6. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

2.8 STATUS SENSORS

- A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg.
- B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig, piped across pump.
- C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.
- D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.
- E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.
- F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.
- G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

2.9 GAS DETECTION EQUIPMENT

- 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. CEA Instruments, Inc.
 2. Ebtron, Inc.
 3. Honeywell Building Solutions; Honeywell International, Inc.
 4. I.T.M. Instruments Inc.
 5. INTEC Controls, Inc.

6. MSA Canada Inc.
7. Sensidyne, Inc.
8. TSI Incorporated.
9. Vaisala.
10. Veris Industries.
11. Vulcain Inc.

- B. Carbon Monoxide Detectors: Single or multichannel, dual-level detectors using solid-state plug-in sensors with a 3-year minimum life; suitable over a temperature range of 32 to 104 deg F; with 2 factory-calibrated alarm levels at 50 and 100 ppm.

2.10 THERMOSTATS

- 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. Danfoss Inc.
2. Erie Controls.
3. Heat-Timer Corporation.
4. Sauter Controls Corporation.
5. tekmar Control Systems, Ltd.
6. Theben AG - Lumilite Control Technology, Inc.
7. Veris Industries.

- B. Electric, solid-state, microcomputer-based room thermostat with remote sensor.

1. Automatic switching from heating to cooling.
2. Preferential rate control to minimize overshoot and deviation from set point.
3. Set up for four separate temperatures per day.
4. Instant override of set point for continuous or timed period from 1 hour to 31 days.
5. Short-cycle protection.
6. Programming based on every day of week.
7. Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.
8. Battery replacement without program loss.
9. Thermostat display features include the following:
 - a. Time of day.
 - b. Actual room temperature.
 - c. Programmed temperature.
 - d. Programmed time.
 - e. Duration of timed override.
 - f. Day of week.
 - g. System mode indications include "heating," "off," "fan auto," and "fan on."

- C. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.

- D. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.
1. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
 2. Selector Switch: Integral, manual on-off-auto.
- E. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.
1. Bulbs in water lines with separate wells of same material as bulb.
 2. Bulbs in air ducts with flanges and shields.
 3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
 4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
 5. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.
 6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.
- F. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.
- G. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable set point in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.
- H. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.
1. Bulb Length: Minimum 20 feet.
 2. Quantity: One thermostat for every 20 sq. ft. of coil surface.
- I. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.
1. Bulb Length: Minimum 20 feet.
 2. Quantity: One thermostat for every 20 sq. ft. of coil surface.
- J. Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, with molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25 psig, and cast housing with position indicator and adjusting knob.

2.11 HUMIDISTATS

- 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. MAMAC Systems, Inc.
 2. ROTRONIC Instrument Corp.
 3. Veris Industries.
- B. Duct-Mounting Humidistats: Electric insertion, 2-position type with adjustable, 2 percent throttling range, 20 to 80 percent operating range, and single- or double-pole contacts.

2.12 ACTUATORS

- A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
1. Comply with requirements in Section 23 00 10
 2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
 3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
 4. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.
 5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
 6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
- B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
1. Manufacturers: Subject to compliance with requirements, provide products by the following or approved equal to the following:
 - a. Belimo Aircontrols (USA), Inc.
 2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
 3. Dampers: Size for running torque calculated as follows:
 - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
 - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
 - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. of damper.
 - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.

- e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
 - f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
- 4. Coupling: V-bolt and V-shaped, toothed cradle.
 - 5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 - 6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
 - 7. Power Requirements (Two-Position Spring Return): 24V ac.
 - 8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
 - 9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
 - 10. Temperature Rating: Minus 22 to plus 122 deg F.
 - 11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.
 - 12. Run Time: 12 seconds open, 5 seconds closed.

2.13 FLOW MEASURING STATIONS

A. Duct Airflow Station: Refer to Section 23 33 00

B. Insertion Flow Meters

- 1. Insertion flow meters shall be of the dual turbine analog output type or electromagnetic as indicated and manufactured by Onicon Model F-1210 and F-3500 or approved equal.
- 2. All wetted metal parts of meter shall be of 316 stainless steel construction. Turbine shafts shall be Tungsten carbide with sapphire axial and radial bearings. Turbines shall be of low mass nonmetallic construction.
- 3. Turbine rotation impedance sensing method shall be nonmagnetic and nonphotoelectric. Volumetric accuracy shall be $\pm 4\%$ of reading over entire operating range.
- 4. Meter shall be suitable for a continuous operating temperature of 200°F and an operating pressure of 400 psi.
- 5. All meters shall be factory calibrated to within $\pm 0.5\%$ accuracy of the specified flow condition.
- 6. The meter shall have the following characteristics:
 - a. Analog Output:
 - b. Non-Interactive Zero and Span Adjustments
 - c. DC Linearity: 0.1% of span
 - d. Voltage Output: 0.10V
 - e. Current Output: 4-20 mA
 - f. Frequency Output: 0-16 VDC, peak to peak

g. Power Supply: 24 ± 4 VDC @ 50 mA

7. Meter shall be in accordance with AWWA Standard C704-70 and shall be complete with hot tap adapter with valve assembly for steel pipe.

2.14 CONTROL VALVES

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. Danfoss Inc.
2. Erie Controls.
3. Hayward Flow Control.
4. Magnatrol Valve Corporation.
5. Neles-Jamesbury.
6. Paragon Controls, Inc.
7. Parker Hannifin Corporation.
8. Pneuline Controls.
9. Sauter Controls Corporation.

B. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

C. Hydronic system globe valves shall have the following characteristics:

1. NPS 2 and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
2. NPS 2-1/2 and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
3. Internal Construction: Replaceable plugs and stainless-steel seats.
 - a. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.
4. Sizing: 3-psig maximum pressure drop at design flow rate or the following:
 - a. Two Position: Line size.
 - b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
 - c. Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.
5. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump)

head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

D. Steam system globe valves shall have the following characteristics:

1. NPS 2 and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
2. NPS 2-1/2 and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
3. Internal Construction: Replaceable plugs and stainless-steel seats.
 - a. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom of guided plugs.
4. Sizing: For pressure drop based on the following services:
 - a. Two Position: 20 percent of inlet pressure.
 - b. Modulating 15-psig Steam: 80 percent of inlet steam pressure.
 - c. Modulating 16- to 50-psig Steam: 50 percent of inlet steam pressure.
 - d. Modulating More Than 50-psig Steam: As indicated.
5. Flow Characteristics: Modified linear characteristics.
6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of operating (inlet) pressure.

E. Butterfly Valves: 200-psig, 150-psig maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.

1. Body Style: Lug.
2. Disc Type: Aluminum bronze.
3. Sizing: 1-psig maximum pressure drop at design flow rate.

F. Terminal Unit Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.

1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
2. Sizing: 3-psig maximum pressure drop at design flow rate, to close against pump shutoff head.
3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

2.15 DAMPERS

A. See Section 23 33 00 "Ductwork and Accessories".

2.16 CONTROL CABLE

- A. Electronic and fiber-optic cables for control wiring are specified in Sections 27 13 23 "Communications Optical Fiber Backbone Cabling" and 27 15 13 "Communications Copper Horizontal Cabling."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that conditioned power supply is available to control units and operator workstation.
- B. Verify that pneumatic piping and duct-, pipe-, and equipment-mounted devices are installed before proceeding with installation.

3.2 INSTALLATION

- A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
- B. Connect and configure equipment and software to achieve sequence of operation specified.
- C. Verify location of thermostats, humidistats, and other exposed control sensors with Owner, Architect, Drawings and room details before installation. Generally, devices shall be installed 48 inches above the floor.
 - 1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- D. Install guards on thermostats in the following locations:
 - 1. Entrances.
 - 2. Public areas.
 - 3. Where indicated on drawings.
- E. Install automatic dampers according to Section 23 33 00.
- F. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- G. Install labels and nameplates to identify control components according to Section 23 00 50
- H. Install hydronic instrument wells, valves, and other accessories according to Section 23 00 50.
- I. Install steam and condensate instrument wells, valves, and other accessories according to Section 23 00 50.

- J. Install refrigerant instrument wells, valves, and other accessories according to Section 23 00 50.
- K. Install duct volume-control dampers according to Section 23 33 00.
- L. Install electronic and fiber-optic cables according to Sections 27 13 23 "Communications Optical Fiber Backbone Cabling" and 27 15 13 "Communications Copper Horizontal Cabling."

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install raceways, boxes, and cabinets according to Section 26 05 33 "Raceways and Boxes for Electrical Systems."
- B. Install building wire and cable according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- C. Install signal and communication cable according to Sections 27 13 23 "Communications Optical Fiber Backbone Cabling" and 27 15 13 "Communications Copper Horizontal Cabling."
 - 1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 - 2. Install exposed cable in raceway.
 - 3. Install concealed cable in raceway.
 - 4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
 - 5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 - 6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 - 7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties.
3. Test calibration electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
4. Test each point through its full operating range to verify that safety and operating control set points are as required.
5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
6. Test each system for compliance with sequence of operation.
7. Test software and hardware interlocks.

C. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material, and support.
5. Check installation of air supply for each instrument.
6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
8. Check temperature instruments and material and length of sensing elements.
9. Check control valves. Verify that they are in correct direction.
10. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
11. Check DDC system as follows:
 - a. Verify that DDC controller power supply is from emergency power supply, if applicable.
 - b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
 - c. Verify that spare I/O capacity has been provided.
 - d. Verify that DDC controllers are protected from power supply surges.

- D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.5 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.

3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
 4. Control System Inputs and Outputs:
 - a. Check analog inputs at 0, 50, and 100 percent of span.
 - b. Check analog outputs using milliamper meter at 0, 50, and 100 percent output.
 - c. Check digital inputs using jumper wire.
 - d. Check digital outputs using ohmmeter to test for contact making or breaking.
 - e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
 5. Flow:
 - a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
 - b. Manually operate flow switches to verify that they make or break contact.
 6. Pressure:
 - a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
 - b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
 7. Temperature:
 - a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
 - b. Calibrate temperature switches to make or break contacts.
 8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
 9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
 10. Provide diagnostic and test instruments for calibration and adjustment of system.
 11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.
- B. Adjust initial temperature and humidity set points.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Section 01 79 00 "Demonstration and Training."
- B. Provide video recording of training in accordance with Section 01 79 00 "Demonstration and Training."

END OF SECTION 23 09 00

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SECTION 23 09 23

GAS INSTRUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Provide a complete installation of a toxic gas detection system including a main control panel, sensors and audible/visual alarm devices that can be linked to a Controller or a Building Automation System (BAS) as required.
- B. The system shall include, but not be limited to, the following:
 - 1. Future expandability.
 - 2. Display of toxic gas concentrations.
 - 3. Ability to modify alarm setpoints.
 - 4. Display of alarm status.
- C. Section Includes the Following Gas Instruments:
 - 1. Multipoint carbon-monoxide monitoring system.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product, including the following:
 - 1. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
 - 2. Installation instructions, including factor affecting performance.
 - 3. Product description with complete technical data, performance curves, product specification sheets.

PART 2 - PRODUCTS

2.1 MULTIPOINT CARBON-MONOXIDE MONITORING SYSTEM

- A. Controller:

1. Provide gas detection controller Honeywell Analytics 301-C-DLC or approved equal by alternate manufacturer.
2. The control panel must be capable of communicating digitally with the networked transmitters and relay modules through three RS-485 Modbus communication buses. Each communication bus must be capable of accepting a combination of up to 32 addressable transmitters, relay modules or annunciator panels at a maximum distance of 2,000 feet. The power supply shall be of either 17-27 V ac or 24-38 V dc.
3. The controller will manage four internal DPDT relays at fully programmable alarm levels (and within programmable time delays) and be capable of activating multiple relay modules of eight relays each. The relay rating will be no lower than 5 A, 30 Vdc or 250Vac (resistive load).
4. The controller must include a self-test function that allows for the activation/deactivation of all the programmed outputs by simulating a continuous 5% increase/decrease value until the maximum/minimum value is reached.
5. The controller must include a real-time clock that enables operation of the outputs for a specific timeframe.
6. The controller must also include an energy saving feature that allows for output operation on alarms set at the max, min or average value of a specific group of transmitters. This feature must also allow for the activation of outputs upon a certain number of a specific group ($\frac{3}{4}$, $\frac{1}{2}$, $\frac{1}{3}$ and $\frac{1}{4}$) of transmitters reaching their alarm levels. A total of 128 groups can be assigned.
7. The controller will be capable of communicating with an optional relay module (equal to Honeywell 301-R8) that will provide (8) additional, fully programmable DPDT relays.
8. The controller will indicate the exact concentration of gas, the gas detected, and the location of the sensor by sweeping through the network and displaying the detected levels at each point on a graphic LCD display.
9. The controller must enable BACnet™ communication through its BACnet output using BACnet/IP protocol over twisted-pair Ethernet (10BaseT) wires.
10. Data logging capability must provide long-term data logging to determine trends. The controller must collect data automatically and must store it on a digital Flash media card.

B. Toxic Gas Detector:

1. Provide toxic gas detectors Honeywell Analytics E3 Point E3SM+E3SCO or approved equal by alternate manufacturer.
2. Transmitter will be powered by the control panel power supply rated at 24 Vac. Fully addressable gas transmitter must be capable of communicating digitally with controller through an RS-485 communication port. Gas transmitters must be

installed in a true daisy chain with an end of the line resistor on the last transmitter. The gas transmitter will incorporate an electrochemical cell for toxic gas monitoring and catalytic bead sensor for combustible gases. Unit sensing cell must compensate for variations in relative humidity and temperature to maintain high levels of accuracy.

3. When placed in a network configuration the transmitter will be capable of transmitting gas concentrations through the controller. For local activation of fans or louvers (or other equipment) an on-board DPDT relay 5 A, 30 Vdc or 250 Vac (resistive load) will be activated at programmable set points (and programmable time delays) through the control panel. An LCD display will provide gas concentration readings.
4. Transmitter will be capable of operating within relative humidity ranges of 5-95% and temperature ranges of -4° F to 104° F (-20° C to 40° C).
5. Unit will be certified to ANSI/UL 61010-1 label and CAN/CSA-C22.2 No. 61010-1. Transmitter must be manufactured in an ISO 9001-2000 production environment.
6. The transmitter should have a plug-in capability for a gas cartridge with a smart sensor capable of self-testing.
7. For local activation of audible alarms, the transmitter shall have an on-board device able to generate an audible output of 85 dBA @ 10 ft (3 m).
8. Detector alarm levels are to be activated and the unit is to be installed in accordance with the following parameters:

TOXIC GASES	1st ALARM SET POINT (TLV-TWA)	2nd ALARM SET POINT (TLV-STEL)	3 rd ALARM SET POINT	MOUNTING HEIGHT	COVERAGE RADIUS	COVERAGE RADIUS
Carbon Monoxide (CO)	25 PPM (60 sec. "be- fore" delay)	200 PPM	225 PPM	5 ft above fin- ished floor	50 ft	50 ft

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
- C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Install hazardous gas monitoring equipment including sensors, audible alarms, panels as shown on Contract Drawings, and as recommended by manufacturer of equipment, and as required by authorities having jurisdiction.
- B. Install conduit and wiring from sensors to control panel and to the fan starters/ HVAC control panel as recommended by manufacturer of equipment.
- C. Furnish and install products required to satisfy more stringent of all requirements indicated.
- D. Install products level, plumb, parallel, and perpendicular with building construction.
- E. Properly support instruments, tubing, piping, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to seismic loads.
- F. Fastening Hardware:
 - 1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
 - 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by using excessive force or oversized wrenches.
 - 3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
- G. Install products in locations that are accessible and that permit calibration and maintenance.

3.3 ELECTRICAL POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
- C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Provide 120V to 24V controls transformers equal to Honeywell M-600400 or approved equal from alternate manufacturer. Coordinate exact sizing and model of controls transformer with selected gas detection system manufacturer as power requirements may vary.

3.4 INSTRUMENTS, GENERAL INSTALLATION REQUIREMENTS

A. Mounting Location:

1. Install carbon monoxide sensor in the locations indicated on contract drawings.

B. Mounting Height:

1. Carbon monoxide sensors: Make every effort to mount at 60" above finished floor.

3.5 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. After installation, test and calibrate equipment to demonstrate operation of functions described above under sequence of operation by manufactures certified service center.
2. Provide testing kits (including gas bottles) for testing and calibration by Commission forces.
3. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
4. For each analog instrument, perform a three-point calibration test for both linearity and accuracy.
5. Equipment and procedures used for calibration shall comply with instrument manufacturer's written recommendations.
6. Provide diagnostic and test equipment for calibration and adjustment.
7. Field instruments and equipment used to test and calibrate installed instruments shall have an accuracy of at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
8. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
9. If, after calibration, indicated performance cannot be achieved, replace out-of-tolerance instruments.
10. Comply with field-testing requirements and procedures in ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.

B. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

3.6 MAINTENANCE SERVICE

- #### A. Maintenance Service:
- Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of gas system and equipment.. Include annual preventive maintenance, repair or replacement of worn or defective components, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.
- B. Coordinate gas instrument demonstration video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.
- C. Record videos on DVD disks.
- D. Owner shall have right to make additional copies of video for internal use without paying royalties.

3.8 WARRANTY

- A. Manufacturer shall provide a minimum 12 month warranty covering defects in material or workmanship whereas such parts shall be repaired or replaced free of charge.

END OF SECTION 23 09 23

SECTION 23 21 23

HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This section includes pumps for heating, ventilating and air conditioning systems as indicated on the drawings and described herein.
- B. Types of pumps specified in this section include the following:
 - 1. End Suction Base Mounted
 - 2. Closed Coupled Inline
 - 3. Split Coupled Inline

1.3 COMMISSIONING

- A. Division 23 will be responsible to carry out the commissioning requirements specified in Section 23 00 10, and 23 08 00.

1.4 SUBMITTALS

- A. Submit shop drawings for all materials specified in this section in accordance with Section 23 00 50.
 - 1. Include construction details, materials descriptions, dimensions of individual components and profiles, and finishes for the product.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Include plans, elevations, sections, and mounting or attachments details.
 - 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 4. Include diagrams for power, signal, and control wiring.
 - 5. Operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PUMPS

- A. General
 - 1. Pump capacities shall be as scheduled on the drawings.

2. Reference Motor Specification Section 23 00 10 for efficiency and construction compliance. The motors shall be ODP or design.
3. Data submitted for approval shall include pump speed and characteristic curves for performance of the impeller selected. Curves shall indicate capacity vs. head, NPSHR, efficiency and brake horsepower for the full range, from shut-off head to free delivery. Manufacturers' pumps may be considered only if pump efficiencies are equal or greater than the basis of design.
4. Vibration isolation shall be provided as specified in Section 23 00 50.
5. Base ells or support shall be provided under piping risers from pump and risers shall further be supported by calibrated spring hangers. Where pump arrangement precludes the use of base elbows or comparable supports, piping shall be supported by means of spring loaded hangers calibrated for the specific use. Pump isolation bases shall be sized to accommodate the support ells.
6. Pumps shall be selected so that the operating point on the selected impeller curve will be at or to the left of, and not more than 5% below, the point of maximum efficiency. Impeller size for specified duty shall not exceed 90% of volute diameter.
7. Pumps shall be provided with motors conforming to Section 23 00 10. Motors shall not exceed 1750 rpm unless noted on pump schedule. Pumps shall be non-overloading with respect to nameplate horsepower throughout the impeller performance curve, unless specifically noted on pump schedule.
8. Suction diffuser, where indicated, angle or straight pattern shall be rated for 175-psig. Construction shall be cast-iron body, end cap, and pump inlet fitting, with bronze startup and stainless permanent strainers; bronze or stainless steel straightening vanes; drain plug, and factory or field-fabricated support.
9. The flush line to the mechanical seal shall be equipped with a 50 micron cartridge filter or when the pump differential exceeds 30 PSIG, a cyclone separator can be utilized with a signal flow indicator. The mechanical contractor shall change the filters after the system has been flushed and on a regular basis until the pumps are turned over to the Owner. At final acceptance new filters shall be provided.
10. All flexibly coupled pumps shall be aligned with a laser alignment system. Laser alignment reports for each pump shall be turned over to the Owner in the pump O&M package.

B. Type "A" Pump (End-suction based-mounted)

1. Pump shall be a centrifugal horizontal frame-mounted end suction type. Pumps shall be capable of achieving performance as scheduled.
2. The casing shall be of the end suction design with centerline discharge outlet in order to facilitate case venting. The casing shall have tapped and plugged holes for priming, draining, and gauges. The casing shall be constructed of cast iron for working pressures below 175 psig at 150 deg. F (125 psig ANSI flange rating) and Ductile Iron for working pressures to 375 psig at 150 def. F (250 psig ANSI flange rating.) The casing bore shall be large enough to allow "back pullout" of the impeller without disturbing the casing or suction and discharge piping. For suction piping diameters of 2" or less and discharge piping diameters of 1.5" or less, the suction and discharge connections shall be NPT threaded. For suction piping diameters of 2.5" or greater and discharge piping diameters of 2" or

- greater, the suction inlet shall be a flat-faced flange connection and the discharge outlet shall be a bolt through flange connection. Flange connections shall be ANSI 125 psig rated. The casing shall be supported by the power frame.
3. The impeller shall be of the enclosed type, vacuum cast in one piece and constructed of bronze, ASTM B584. The impeller shall be finished, the exterior being turned and the interior being finished smooth and cleaned. The impeller shall be dynamically balanced. The impeller shall be keyed to the shaft, fastened with a washer, gasket and capscrew.
 4. The pump casing shall be fitted with a case wear ring to minimize abrasive and corrosive wear to the casing. The case wear ring shall be bronze, ASTM B62, of the radial type, press fitted into the casing.
 5. Shaft sealing shall be accomplished by means of a John Crane Mechanical seal suitable for 225 degree F operation. The seal shall have a Tungsten carbon seat, carbon washer, Buna-N elastomers, and stainless steel metal parts. For open condenser water applications the mechanical seal shall have "hard faced seals", silicon carbide on silicon carbide. The mechanical seal shall be internally – flushed.
 6. The impeller shall be direct-coupled to the power frame shaft. The shaft shall be machined to provide an impeller keyway, and drilled and tapped to accept the impeller fastener. The impeller shaft extension shall conform to NEMA-JM specifications. The outboard shaft extension shall be machined with a keyway to accept a coupling to the driving unit. The shaft shall be steel AISI C1045.
 7. The pump shaft shall be fitted with a shaft sleeve to minimize shaft wear. The sleeve shall be sealed to the impeller hub by an O-ring, and shall be positively driven by a pin to the keyway. The shaft sleeve shall be Type 316 stainless steel.
 8. The power frame shall house a permanently lubricated single-row inboard ball bearing and permanently lubricated single-row outboard thrust bearing. Both bearings shall be selected for a 3 year minimum life at maximum load.
 9. The pump and motor shall be mounted on a groutable formed steel baseplate with integral drip channels incorporated on each side. Each channel shall include an NPT drain connection and plug.
 10. On full speed applications provide T.B. Woods flexible spaced coupling, equipped with coupling guards conforming to the requirements of ANSI B15.1. OSHA compliant coupling guards which fully enclose the coupling will be provided in lieu of standard steel shield. Variable speed applications must be supplied with a Dodge Paraflex coupler with a standard guard. Comply with pump and coupling manufacturers' written instructions. Final alignment shall be made on-site, after the pump is installed and brought up to final operating temperatures. All flexibly coupled pumps must be aligned with a laser alignment system. Laser alignment reports for each pump must be turned over to the owner in the pump O&M package. The mechanical contractor is responsible for providing this service.
 11. Pumps shall be manufactured by Armstrong Pumps, Inc., Taco Pumps, Bell & Gossett Pumps, Weinman, Grundfos or Aurora.

C. Type "B" Pump (Close Coupled Inline for use up to 5 HP)

1. Pump shall be close coupled vertical or horizontal in-line type, single stage design. The pumps shall be capable of being serviced without disturbing piping connections.
2. Cast iron, suitable for 175 psig working pressure at 140 deg. F or. The casing shall incorporate a seal vent line to facilitate air removal and promote continuous water flush across the seal faces. The casing shall have tapped and plugged holes for priming, draining, and gauges.
3. The impeller shall be of the enclosed type, vacuum cast in one piece and constructed of bronze, ASTM B584. The impeller shall be finished, the exterior being turned and the interior being finished smooth and cleaned. The impeller shall be dynamically balanced. The impeller shall be keyed to the shaft, fastened with a washer, gasket and capscrew.
4. Shaft sealing shall be accomplished by means of a John Crane Mechanical seal suitable for 225°F operation. The seal shall have a ceramic seat, carbon washer, Buna-N elastomers, and stainless steel metal parts.
5. The pump shaft shall be ground and polished stainless-steel shaft with stainless steel sleeve.
6. Pumps shall be manufactured by Armstrong Pumps, Inc., Taco Pumps, Bell & Gossett Pumps, Weinman, Grundfos or Aurora.

D. Type "C" Pump (Split Coupled Inline for use on 5 HP and larger)

1. Vertical, in-line, centrifugal, single-stage or double suction type, radially split case design, split-coupled motor assembly (direct-coupled pumps will not be acceptable when motor horsepower is 5 HP and larger). Vertically mounted horizontal split case pumps will not be accepted.
2. Cast iron for working pressures below 175 psig at 150 deg. F (125 psig ANSI flange rating) and Ductile Iron for working pressures to 375 psig at 150 deg. F (250 psig ANSI flange rating). Suction and discharge connections shall be flanged with tapings for seal flush and gauge connections.
3. The impeller shall be of the enclosed type, vacuum cast in one piece and constructed of bronze, ASTM B584. The impeller shall be finished, the exterior being turned and the interior being finished smooth and cleaned. The impeller shall be dynamically balanced. The impeller shall be keyed to the shaft, fastened with a washer, gasket and capscrew.
4. Include outside or inside stainless steel multi-spring secondary mechanical seals with Viton rated for 125-psig minimum working pressure and a continuous water temperature of 225°F. Provide bronze gland plate with stainless steel hardware including a factory installed external flush line with manual vent. For open condenser water applications the mechanical seal shall have "hand faced seals", silicone carbide on silicon carbide.
5. The pump shaft shall be ground and polished stainless-steel shaft with stainless steel sleeve.
6. The coupling shall be a rigid spacer type of high tensile aluminum alloy. Couplings shall be split to allow removal from pump and motor shafts, leaving space between the shafts sufficient to replace all mechanical seal components without disturbing the pump or motor. Coupling must be protected by a removable guard. Filed alignment must not be required by coupling design.
7. Pumps shall be manufactured by Armstrong Pumps, Inc., "4300 Series", Taco Pumps, "KS Series", or Paco Pumps, "Split Coupled Series", Aurora, "Model 382 A", "Bell & Gossett".

PART 3 - EXECUTION

3.1 GENERAL

- A. Install all equipment in accordance with manufacturer's printed instructions and as indicated. Provide all required utilities, wiring, and accessories indicated or required. Properly test each piece of equipment to assure proper operation and demonstrate same to Owner's designated representative. Remove and replace at no expense to the Owner any item of equipment deemed by the Architect to be unsatisfactory.
- B. Provide start-up and adjustments for all systems and equipment in accordance with the manufacturer's recommendations using personnel who are factory trained and certified by factory as factory authorized personnel.

3.2 START-UP COMMISSIONING

- A. Verify that shipping, blocking, and bracing are removed.
- B. Verify that equipment is secure on mountings and supporting devices and that connections to piping and electrical systems are complete.
- C. Verify proper rotation and proper thermal-overload.
- D. Provide lubrication of all components with factory-recommended lubricants.
- E. Verify operating safeties are in place, piped or discharging to a safe location and functional prior to startup including but limited to the following:
 - 1. Electrical – Overloads installed, disconnects accessible, equipment covers and guards installed.
 - 2. Provide documentation of all pressure testing (piping and pressure vessels).
 - 3. Protect all equipment/systems operating during temporary or start-up operation. Provide startup filtration (water), strainers (water) to protect equipment.
 - 4. Check alignment of pump drives. Perform laser alignment of all flexibly coupled pumps. Submit final reports with O&M manuals.
 - 5. Retouch any marred or scratched factory-finished surfaces with materials furnished by the manufacturer.

END OF SECTION 23 21 23

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SECTION 23 25 00

HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes the following HVAC water-treatment systems:
 - 1. Closed hydronic water system(s) including chemistry, equipment and controls
 - 2. Monitoring and service of water treatment systems

1.3 COMMISSIONING

- A. Division 23 will be responsible to carry out the commissioning requirements specified in Section 23 00 10, and 23 08 00.

1.4 PERFORMANCE REQUIREMENTS

- A. Water quality for HVAC systems shall minimize corrosion, scale formation and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment. Owner shall retain/own all the feed and control equipment associated with the treatment program.
- B. Base water treatment product selections on the quality of makeup water available at project site taking into account the materials of construction for the HVAC systems and the performance requirements of this section.
- C. Closed hydronic systems, including hot-water, chilled water and glycol systems, shall have the following water qualities unless aluminum materials of construction are present.
 - 1. pH: Maintain a value between 9.0 to 10.5.
 - 2. Soluble copper: Maintain a maximum value of 0.20 ppm.
 - 3. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
 - 4. Total Aerobic Plate Count: Maintain a maximum value of 1,000 CFU/ml or less.

1.5 SUBMITTALS

- A. Submit shop drawings for all materials specified in this section in accordance with Section 23 00 50.
- B. Shop drawings: Pretreatment and chemical treatment equipment for all HVAC systems including the following:

1. Provide layout and physical dimensions for all of the water treatment components to be installed in the mechanical room.
 2. If the treatment systems are to be installed outside of the mechanical room, include location, physical size and manufacturer of the supplemental weatherproof storage shed to be used.
 3. Include wiring diagrams for all field power and control wiring.
 4. Show all piping connections required to include inlet(s), outlet(s) and drain(s) along with associated connection size.
- C. Include plans, elevations, sections, details, and attachments to other work.
- D. Operation and maintenance manuals for controllers, chemical injection pumps, feeders, timers, valves, and system accessories.
- E. List of chemicals to be used for each system: Use generic names. Provide Safety Data Sheets (SDS) for each chemical used.
- F. Laboratory make-up water sample analyses: Submit a copy of the project site make-up water analysis to document the water quality available at the project site. Make-up water test analysis to include at a minimum the analysis of the following compositions of the water:
- Calcium Hardness (as ppm CaCO₃)*
Total Hardness (as ppm CaCO₃)
Total Alkalinity (as ppm CaCO₃)
pH
Silica (as SiO₂)
Specific Conductivity (μS/cm)
Sulfate (as SO₄)
Chloride (as Cl)
Phosphate (as PO₄)
- G. Provide a list of all services to be provided for all systems and the proposed procedure for system cleaning.

1.6 QUALITY ASSURANCE

- A. The water treatment vendor shall be an experienced water treatment service provider capable of analyzing water qualities and applying water treatment as specified in this section. The vendor shall:
1. Obtain water samples from the site and furnish a laboratory analysis of the make-up water supply.
 2. Review the make-up water analysis and materials of construction to ensure compatibility with the water treatment program and provide cycles of concentration calculations. See Schedule C.
 3. Propose water treatment program required to maximize water efficiency based on Schedule C calculations; minimize material handling and storage while minimizing scale, corrosion and biological growth. Submit all of the above with shop drawings and other required submittals.

4. Chemicals selected shall comply with all the requirements of the American Public Health Association (APHA), the Environmental Protection Agency (EPA) and local environmental agencies.
5. Electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 WATER TREATMENT

- A. Complete chemical water treatment equipment and service shall be provided for the hydronic water systems by a vendor approved under the current state contract. The treatment service shall provide all specified hardware, chemicals, and labor necessary for proper treatment for the specified warranty period for the following systems:

Hot Water Heating Systems

- B. The system shall provide service visits and reports, on a monthly basis as a minimum, for the purpose of monitoring performance, sampling and adjustments in treatment levels to achieve the desired results. At the end of the specified warranty period, the treatment company shall submit a detailed service report with complete records of previous adjustments and chemicals injected. Leave reports on site with the Owner after every service visit.
- C. The treatment company shall be responsible for damage to mechanical systems as a result of improper levels of treatment and/or damaging chemicals. The treatment company will not be responsible if the systems lose excessive amounts of water due to leakage.
- D. The water treatment contractor shall provide monthly reports after each required site visit. Reports shall be signed and received by the building's system operator.
- E. The water treatment contractor shall assist the mechanical contractor in the proper routing of piping and correct wiring requirements for the specific water treatment equipment installed.
- F. The water treatment program under this contract shall be provided for a period of one year from the date of system acceptance by the Owners' representatives. An initial dose of chemical shall also be applied immediately after each system is initially filled with water if operation is delayed after filling. The water treatment company shall provide chemical feeding devices during the period of the contract. At the termination of the contract, the treatment equipment shall belong to the Owner.

2.2 CLOSED LOOP CHEMICAL FEED EQUIPMENT

- A. Bypass feeder shall have a minimum working pressure of 200 psi at 200 degrees F. Capacity shall be 5 gallons minimum. Feeder shall be furnished with inlet assembly and drain assembly, including isolation valves and fittings. Fill opening shall be 3 ½-inches.

B. Corrosion Coupon Rack:

1. Provide a three-station corrosion coupon rack constructed of Schedule 80 PVC, complete with piping, flow control valve and isolation valves. Entire assembly shall be mounted on a panel suitable for wall or rack mounting.
 - a. For hot water loops or closed systems operating above 120F carbon steel materials should be used in lieu of PVC.
2. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.
3. Provide (1) mild steel and (1) copper coupon for initial 90 day analysis of each water system. Coupons shall be installed for at least 90 days and no longer than 120 days.

C. Make-up Water Meter:

1. Cold water, positive displacement, oscillating-piston, magnetic-drive, contacting totalizing meter
2. Must meet AWWA C700-15 standard
3. Minimum working-pressure rating: 30 psi
4. Maximum working-pressure rating: 150 psi
5. Registration: gallons, cubic feet, or liters/cubic meters
6. Controls (contact value or gallons per contact): Flow-control switch with normally open contacts must be rated for maximum 10A and 250 VAC and will close at the predetermined increment of flow.

2.3 CLOSED LOOP CHEMISTRY

- A. The mechanical contractor shall provide approved water treatment vendors with a calculated system volume for each closed loop to be treated at least 72 hours prior to the desired bid date and time. See Schedule A. Water treatment vendors will complete Schedule B and submit by bid due date.
- B. All chemicals shall be compatible with piping system components and all connected equipment and achieve water quality specified in Part 1 "Performance Requirements."
- C. Pre-cleaning chemistry: The cleaning solution shall be formulated to remove light grease, cutting oils, loose mill scale, organics and extraneous construction debris. No alkaline cleaners shall be allowed if any galvanized materials of construction are present. The cleaning program shall consist of the following:
 1. Surfactant
 2. Polymeric dispersant
 3. Non-oxidizing biocide
 4. Antifoam, as required
- D. Hot Loop: A non-oxidizing biocide shall be slug fed semi-annually at a minimum to maintain good control of bacteria. Additional feed may be required if system exceeds listed Performance Requirements (section 1.3 C). The hot loop inhibitor shall be a

multi-functional blend of nitrite, borate, azole and polymer. Dose and maintain the following targets for the hot loop system.

1. Nitrite 500 – 750ppm as NO₂

- E. SDS sheets shall be provided on all chemical products. No systems shall be operated without the benefit of an operational chemical feed system.

2.4 CHEMICAL TREATMENT TEST EQUIPMENT

- A. Testing equipment: Test kits and test equipment shall be available for maintaining control of program standards in the HVAC water systems. Test kits will include the following:
 1. Reagents and apparatus for determination of scale and corrosion inhibitor level in the HVAC water systems.
 2. Reagents and apparatus for determination of pH, alkalinity, free and total chlorine, and calcium hardness.
 3. Dip-slides for determination of microbiological colony population and biocide effectiveness.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

- A. Perform an analysis of supply makeup water to determine the type and quantities of chemical treatment needed to maintain the water quality as specified in "Performance Requirements".

3.2 INSTALLATION AND SERVICES

- A. Completely coordinate with work of all other trades.
- B. Install treatment equipment level and plumb and include all recommended clearances.
- C. Installation of water treatment equipment shall follow all recommendations from water treatment equipment vendor.
- D. Install water meter(s).
- E. Install corrosion coupon rack(s). Coupon rack(s) supply and return piping shall be piped using Schedule 80 PVC or carbon steel, copper is not allowed.
- F. The following services shall be supervised by the water treatment system vendor. Vendor shall coordinate installation with the mechanical contractor.
 1. Location and proper installation of liquid chemical containment.
 2. Location and proper installation, including mounting, of any controllers, chemical injection pumps, timers and valves.
 3. All piping and system components that are subject to freeze conditions shall have heat trace and insulation to protect the water treatment system from freezing.

4. If the treatment system is to be installed outside of the mechanical room, a storage shed must be used which includes fans and or heaters to maintain the appropriate climate to prevent freezing and or excessive heat that could jeopardize the treatment chemicals or treatment system operation.
- G. Mechanical contractor shall install filtration system by following all manufacturer's recommendations.
- H. Bypass Feeders: Mechanical contractor shall install a feeder in each closed hydronic system, including hot-water heating, chilled water and glycol cooling:
 1. Install the feeder in a bypass circuit across the recirculating pumps to provide sufficient differential pressure and adequate flow through the feeder, unless otherwise indicated on drawings.
 2. Bypass feeder shall be mounted such that the top of the feeder is no more than 4'0" above the finished floor.
 3. Install water meter in make-up water supply.
 4. Install corrosion coupon rack in bypass circuit around circulating pumps, unless otherwise indicated on drawings. Coupon rack supply and return piping shall be piped using Schedule 80 PVC or carbon steel, copper is not allowed.
 5. Pipe feeder drain to sanitary drain.
 6. Install isolation valves on inlet, outlet, and drain below feeder inlet.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Mechanical contractor shall install piping consistent with submittal drawings. Provide recommended access for service and maintenance.
- C. Piping connections to open condenser water treatment system:
 1. Mechanical contractor will supply two taps with isolation valves on the high pressure side of the main recirculating water pumps along with associated piping to supply condenser water to the chemical treatment skid(s).
 - a. Mechanical Contractor will supply and connect piping from each tap to supply the inlet of each treatment system.
 2. Mechanical contractor will supply two taps with isolation valves on the low pressure side of the main recirculating water pumps along with associated piping to return treated water from the chemical treatment skid(s).
 - a. Mechanical Contractor will supply and connect piping from these low pressure taps to the outlet of each treatment system.
 3. Additional taps, if required, will be the responsibility of the water treatment vendor.
 4. Mechanical contractor will supply and connect drain piping from the treatment skid(s) to a sanitary drain. The drain piping shall be piped for gravity drainage.

5. Mechanical contractor will pipe the two way motorized bleed valve to a sanitary drain connection that is capable of handling the estimated blow down flow. The contractor will test drain prior to ensure drain will handle the amount of water that is released during each controlled blow down. The bleed line shall not be attached to the control loop.
6. Water treatment vendor shall be responsible for installing probes, sensing equipment and chemical feed pumps.

3.4 FLUSHING AND CLEANING

- A. Pre-cleaning of closed loop systems: The water treatment supplier shall be responsible for supervising and furnishing the proper chemical for chemically cleaning all closed and open hydronic water systems. This cleaning program is not intended for potable water systems. The mechanical contractor shall provide labor for the pre-operational cleaning of all closed and open hydronic water systems including all piping and related equipment.
1. The mechanical contractor shall flush all systems, including mud from drop legs. The cooling tower basin must be free of mud, silt and construction debris. Remove, clean and replace all strainers.
 2. A minimum 1-1/2" ball or gate valve is to be permanently installed in the low point of each system for the purpose of draining each system.
 3. Complete circulation must be achieved during the cleaning procedure. A minimum flow rate of 3ft/second needs to be maintained to ensure that the cleaning chemicals work properly. All manual, electrical, air and thermostatic operated valves must be open. All dead end runs must be looped together with piping not less than 1/3 the size of the run. This piping is to remain in place until cleaning is complete.

3.5 FIELD QUALITY CONTROL

- A. All services will be provided by a factory authorized service provider.
- B. The water treatment supplier shall inspect field-assembled components and equipment installation, including piping and electrical connections.
- C. The water treatment system supplier shall be on-site for start-up and commissioning including the following:
1. Start and configure conductivity controller.
 2. Verify proper operation of motorized ball valve installed for bleed.
 3. Perform field tests on makeup water to verify that quality is consistent with laboratory analysis (Section 1.6 A. 1).
 4. Load, prime and start chemical inhibitor feed.
 5. Load, prime and start biocide feed.
- D. Provide water treatment services, for a period of 1-year from start-up of the cooling and heating systems, which will include:
1. Installation and system start-up procedure recommendations.
 2. Initial water analysis and recommendations.

3. Training of operating personnel on proper feeding and control techniques.
4. Monthly field service during periods of wet operation and provide written reports.
5. Any necessary log sheets and record forms.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment. Refer to Section 01 79 00 "Demonstration and Training."

END OF SECTION 23 25 00

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SECTION 23 29 23

VARIABLE FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes separately enclosed, pre-assembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.3 COMMISSIONING

- A. Division 23 will be responsible to carry out the commissioning requirements specified in Section 23 00 10, and 23 08 00.

1.4 SUBMITTALS

- A. Submit shop drawings for all materials specified in this section in accordance with Section 23 00 50:
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the product.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Include plans, elevations, sections, and mounting or attachment details.
 - 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field installation, and location and size of each field connection.
 - 4. Include diagrams for power, signal, and control wiring.
 - 5. Operation and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

1.6 WARRANTY

- A. General Warranty: Manufacturer's standard form in which manufacturer agrees to provide labor and materials to repair or replace VFCs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period shall be 5 years from date of Substantial Project Completion.
 - 2. The warranty period shall start at the date of overall substantial completion for the project.
 - 3. Submit a sample warranty for approval before purchasing equipment.
 - 4. See section 01 77 00 – Closeout Procedures for additional warranty requirements.

PART 2 - PRODUCTS

2.1 VARIABLE TORQUE AC VARIABLE FREQUENCY CONTROLLER: PULSE WIDTH MODULATION TYPE

- A. AC Variable Frequency Controllers shall be provided for pumps and fans as scheduled on the plans. The variable frequency controller (VFC) shall convert three phase 60 Hertz utility power to adjustable voltage and frequency, three phase, AC power for stepless motor control from 10% to 110% of base speed. The VFC shall be as manufactured by ABB, GE, Yaskawa, Danfoss, Eaton, Rockwell Automation (Allen-Bradley), or Toshiba.
- B. The VFC shall be a voltage source type with a PWM output utilizing IGBT transistor semi-conductors. The base VFD shall be UL Listed for 100 KAIC without the need for input fuses.
- C. The VFC shall meet EMI/RFI Product Standard EN61800-3 for First Environment Restricted Level.
- D. Seismic qualifications: By manufacturer, from qualified testing agency, shall comply with International Building Code.
- E. The VFC together with all options and modifications shall be mounted within a standard NEMA 1 enclosure suitable for continuous operation at an ambient temperature of 0o to 40o C with relative humidity to 95% non condensing. All high voltage components within the enclosure shall be isolated with steel covers. The complete unit shall carry UL or ETL listing under standards UL508A and UL 61800-5-1; enclosures shall comply with NEMA 250.
- F. Circuits shall provide DV/DT and DI/DT protection for semi-conductors. VFC shall be capable of starting into a rotating load without delay. Protective circuits shall cause instantaneous trip (IET) should any of the following faults occur:
 - 1. 110% of controller maximum sine wave current rating is exceeded.
 - 2. Output phase to phase and phase to ground short circuit condition.
 - 3. High input line voltage.
 - 4. Low input line voltage.
 - 5. Loss of input phase.
 - 6. External fault. This protective circuit shall permit, by means of the terminal strip, wiring of remote NC safety contacts such as high static, firestat, etc., to de-energize the AFC.
- G. The following adjustments shall be available in the controller and retained in non-volatile memory:
 - 1. Maximum frequency (15 to 500 hz) factory set at 60 hz.
 - 2. Minimum frequency (3 to 60 hz) factory set at 6 hz.
 - 3. Acceleration (.1 to 360 seconds) factory set at 20 seconds.
 - 4. Deceleration (.1 to 360 seconds) factory set at 20 seconds.
 - 5. Volts/Hertz ratio factory set for 460V at 60 hz.
 - 6. Voltage offset or boost factory set at 100% torque.
 - 7. Current limit (50% to 110% sine wave current rating) factory set at 100% current.
- H. The VFC shall have the following basic features:
 - 1. Door mounted operator controls consisting of membrane command center which will enable manual hand-off-auto and speed control, local/remote indication and manual/or automatic speed control selection. In addition, the command center will serve as a means

- to configure controller parameters such as minimum speed, maximum speed, acceleration and deceleration times, volts/hz ratio, and torque boost.
2. Main input disconnect to provide a possible disconnect of all phases of the incoming AC line to both the controller and the bypass circuitry. This disconnect shall be mounted inside the controller enclosure and have through-the-door interlocking toggle with provisions for padlocking.
 3. Input fuses, or circuit breaker overcurrent protective device.
 4. Electronic motor overload relay.
 5. Automatic restart after power outage, drive fault or external fault, with drive in its automatic mode. The circuit shall enable the user to select up to five (5) restart attempts. The reset time between fault occurrences shall also be selectable. All settings shall be via the membrane command center.
 6. Door-mounted LED display for digital indication of:
 - a. Frequency output.
 - b. Voltage output.
 - c. Current output.
 - d. First fault indication.
 7. Relay for remote indication of drive fault and motor running.
 8. Smoke purge circuit to enable acceptance from a contact closure from the building control and monitoring system (BCMS), that will start the controller regardless of mode and operate the motor at a preset adjustable speed.
 9. A minimum of two critical frequency avoidance bands, field programmable via the membrane command center. Each critical frequency avoidance band shall have a bandwidth adjustable via the keypad of up to 10 Hz.
 10. The drive shall be equipped with a direct interface device utilized to provide communication to the building BCMS system via BACNET PROTOCOL, and a USB port for communication with a PC.
 11. Isolated process follower to enable VFC to follow a 4-20 MADC or 0-10VDC grounded or ungrounded signal.
 12. The VFC shall have the capability to ride through power dips or outages up to 16.66 milliseconds without a controller trip.
 13. AC line reactor 5% impedance to minimize line surges, line notching, and voltage distortions, or DC bus choke with 5% impedance (equivalent).
 14. Manual bypass-to-line with magnetic contactors to transfer motor from the VFC to line speed operation on utility supplied input power while the motor is at any speed. Two motor contactors, electrically interlocked shall be utilized, one contactor between the controller output and the motor, and the other between the by pass power line and the motor, providing across the line starting.
 15. Motor protection per the NEC shall be provided in both the "controller" mode and the "bypass" mode by a motor overload relay. The 24 volt DC relay control logic, allowing common start/stop commands in the "controller" mode and the "bypass" mode shall also be included within the enclosure.
 16. In addition to the door interlocked, main power input disconnect providing positive shutdown of all power to both the bypass circuitry and the VFC. The bypass circuit shall provide a service switch to safely trouble shoot and test the controller, both energized and de-energized, while operating the bypass mode. Terminal connectors for over pressurization switches shall be provided, to protect the ductwork in the bypass mode.
 17. Control power transformer, 120VAC secondary, with primary and secondary fuses, sized to operate connected control burden plus 50VA.
- I. For single drive, multiple fan or pump operations, the VFC shall be provided with fuses and overload protection for each fan or pump separately. Termination points shall be provided for

final wiring connections by Division 16. Provide means of disconnect for each pump or fan on enclosure.

- J. Output Filtering: Provide DV/DT output filtering to limit standing waves as required for installed output circuit lead lengths, based on drive manufacturer's guidance.
- K. The manufacturer shall have service and parts suppliers located within a two hour driving distance. Start-up service shall be provided by a factory authorized technician.
- L. The VFC shall carry a full parts and labor warranty for two years from date of start-up.
- M. Provide schematic single line diagrams of the VFC showing all power and control circuits as part of the shop drawing submittal.

PART 3 - EXECUTION

3.1 HARMONIC ANALYSIS STUDY

- A. The VFD manufacturer shall provide calculations; specific to this installation, showing total harmonic voltage distortion is less than 5%. Input filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE standard 519. All VFD's shall include a minimum of 5% impedance reactors, Analyze possible operating scenarios, including recommendations for VFC input filtering to limit TDD and THD(V) at the defined PCC per IEEE 519 to specified levels

3.2 INSTALLATION

- A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Wall-Mounting Controllers: Install VFCs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks.
- C. Install fuses in each fusible-switch VFC.
- D. Install fuses in control circuits if not factory installed.
- E. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- F. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- G. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified.
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label each VFC with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

3.4 CONTROL WIRING INSTALLATION

- A. Install wiring between VFCs and remote devices and facility's central-control system. Comply with requirements in Division 26.
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic control devices where applicable.
 1. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.
 2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Acceptance Testing Preparation:
 1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- C. Tests and Inspections:
 1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
 3. Test continuity of each circuit.
 4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect before starting the motor(s).
 5. Test each motor for proper phase rotation.
 6. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 7. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFC 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

- D. Prepare test and inspection reports, including a certified report that identifies the VFC 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 MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect 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 DEMONSTRATION

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

END OF SECTION 23 29 23

SECTION 23 33 00

DUCTWORK 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. This section includes the air distribution system including those devices distributing the air to the spaces, and those items which collect, filter, control, and convey air.
- B. Except for duct pressure tests, all testing and balancing of the air distribution system shall be performed under Section 23 05 93 of the Specifications.

1.3 COMMISSIONING

- A. Division 23 will be responsible to carry out the commissioning requirements specified in Section 23 00 10 and 23 08 00.

1.4 SUBMITTALS

- A. Submit shop drawings for all materials specified in this section in accordance with Section 23 00 50.
 - 1. Include construction details, materials description, dimensions of individual components and finishes for the product.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Include mounting or attachment details.
 - 3. Include details of equipment assemblies. Indicate dimensions, weight, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 4. Include diagrams for power, signal, and control wiring.

PART 2 - PRODUCTS

2.1 AIR DEVICES

- A. Provide air devices of minimum sizes and quantities indicated and of the types specified. Contractor shall carefully study the drawings and the field conditions to ascertain the air device requirements as to suitability, location, air capacity, required accessories and finish. Devices shall be selected to provide draft-free air distribution over entire area served and sound rating shall not exceed scheduled NC level. Shop drawings shall indicate NC values.
- B. Provide Titus, Krueger, Nailor, Anemostat, or Price air devices in accordance with the enclosed schedule.

- C. Size of grilles and registers indicated on the drawings for installation in acoustical tile grid systems are nominal size. Devices shall be selected to fit standard ceiling tile space within the suspended grid.
- D. Margins and frames shall be as indicated or directed to suit field conditions. Devices shall have plaster frames when installed in plaster or drywall construction.
- E. Finishes shall be as specified herein. Devices installed in acoustical tile ceilings shall be white baked enamel finish.
- F. Finish (off-white) of T-bar diffusers shall match specified ceiling grid system. Perimeter T-bars adjacent to Type "A" diffusers shall be provided by the ceiling contractor. All center T-bars shall be supplied with air device.
- G. All devices located in toilet rooms, locker areas, and kitchens shall be of aluminum construction, unless otherwise specified herein.
- H. Paint ductwork behind grilles and registers with flat black enamel so that bright surface of metal cannot be seen. Properly prime galvanized surface prior to painting.
- I. For air devices furnished with internally lined plenums, provide 1 1/2 lb. density closed cell foam fiber free type.
- J. Provide air devices in accordance with the following schedule. Model number are those of Titus, unless otherwise indicated.

<u>Device</u>	<u>Type</u>	<u>Model</u>	<u>Finish and Frame Type</u>
Plenum Slot Diffuser	A	TBD-30	#26 with center T-Bar
Plenum Slot Diffuser	A7	ML	#26 with center T-Bar
Linear Slot Diffusers	B	Flowbar	
Louvered Ceiling Diffuser	C	TDC	#26 Type 1
Supply Register	G	300RL	#26
Return Register	I	350RL	#26 Type 1 Frame
Return Linear Slot Diffuser	J	Flowbar	
Return Linear Slot Diffuser	K	MLR	#26 Type 2A Border
Linear Return Bar Diffuser	M	CT	#26
Exhaust Register	N	350RL	#26
Security Supply Diffuser	O	Price MSRRCD	White e/tamper-proof Screws
Security Register	P	Price MSRRP	White e/tamper-proof Screws

2.2 FIRE DAMPERS

- A. Fire dampers shall be Ruskin, Air Balance, National Controlled Air, Greenheck, Pottorff, United Enertech or approved equal U.L. labeled dynamic dampers. Damper shall match the wall, floor or ceiling rating in which it is installed, except no damper shall have less than 1-1/2 hour rating. Dampers shall be all welded construction and shall be fitted with integral galvanized sleeves. Dampers shall be Type "B" for low pressure rectangular ducts and Type "C" for circular, flat oval, or rectangular as required for medium pressure ducts. Dampers behind grilles and registers shall be Type "A".
- B. Fire damper assembly shall include fire damper and damper enclosure wall sleeve complete with duct attachment flanges, in accordance with all code requirements. Provide an access door (minimum 12" x 12") at each fire damper located so as to permit easy maintenance of damper and fusible link. Provide 165°F fusible link. All fire dampers shall be installed in accordance with NFPA requirements.
- C. Submit shop drawings indicating installation details, samples upon request, and manufacturer's installation drawings for approval to the Architect of all fire damper assemblies for low pressure and medium pressure duct systems. Dampers shall not be installed prior to receiving written approval of submitted samples.

2.3 COMBINATION FIRE SMOKE DAMPERS

- A. Combination fire smoke dampers shall be 1-1/2 hour rated under UL Standard 555, and shall further be classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems under the latest version of UL555S, and bear a UL label attesting to same. The leakage rating under UL555S for medium pressure duct applications shall be no higher than leakage class I (4 cfm/SF at 1" w.g. and 8 cfm/SF at 4" w.g.). The leakage rating under UL555S for low pressure duct applications shall be no higher than leakage class II (10 cfm/SF at 1" w.g.). Elevated temperature rating shall be 250° F.
- B. Include on submittal data information for evaluation of damper flow characteristics, certified leakage rates and electrical load information (current at specified voltage).
- C. Damper frames shall be constructed of minimum 16 gage galvanized steel channel. Blades for medium pressure duct applications shall be airfoil shaped double skin construction. Blade edge seals shall be silicone rubber designed for smoke seal to 450 degree F. Jamb seal shall be flexible metal compression type. Bearings shall be stainless steel sleeves, pressed into frame. Damper materials shall be consistent with requirements of installed duct systems. Damper sleeve gage shall be in accordance with UL555 and NFPA 90A.
- D. Actuators shall be installed by the damper manufacturer at time of damper fabrication. Actuator shall be normally closed 120 volt AC two position type. Damper and actuator shall be supplied as a single entity which meets all applicable UL555 and UL555S qualifications for both dampers and actuators. Qualified actuators (supplied by damper manufacturer or ATC contractor) shipped loose for field mounting, must bear a U.L. label affixed by the damper manufacturer.

- E. Provide damper test switch and two position blade indicator switch. Provide factory mounted end switch Ruskin Model SP-100 for all dampers.
- F. Combination fire smoke dampers shall be equipped with a fusible link which shall melt at 165° degree F causing damper to close and lock in a closed position.
- G. Combination fire smoke dampers for medium pressure duct applications shall be Ruskin Model FSD-60 or approved equal by Greenheck, Air Balance, NCA, Pottorff or United Enertech. Combination fire smoke dampers for low pressure duct applications shall be Ruskin Model FSD-36 or approved equal.

2.4 SMOKE DAMPERS

- A. Smoke dampers shall be classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems under the latest version of UL555S, and bear a UL label attesting to same. The leakage rating under UL555S for medium pressure duct applications shall be no higher than leakage class I (4 cfm/SF at 1" w.g. and 8 cfm/SF at 4" w.g. The leakage rating under UL555S for low pressure duct applications shall be no higher than leakage class II (10 cfm/SF at 1" w.g.). Elevated temperature rating shall be 250°F.
- B. Include on submittal data information for evaluation of damper flow characteristics, certified leakage rates and electrical load information (current at specified voltage).
- C. Damper frames shall be constructed of minimum 16 gage galvanized steel channel. Blades for medium pressure duct applications shall be airfoil shaped double skin construction. Blade edge seals shall be silicone rubber designed for smoke seal to 450 degree F. Jamb seal shall be flexible metal compression type. Bearings shall be stainless steel sleeves, pressed into frame. Damper materials shall be consistent with requirements of installed duct systems. Damper sleeve gage shall be in accordance with UL555 and NFPA 90A.
- D. Actuators shall be installed by the damper manufacturer at time of damper fabrication. Actuator shall be normally closed 120 volt AC two position type. Damper and actuator shall be supplied as a single entity which meets all applicable UL555 and UL555S qualifications for both dampers and actuators. Qualified actuators (supplied by damper manufacturer or ATC contractor) shipped loose for field mounting, must bear a U.L. label affixed by the damper manufacturer.
- E. Provide damper test switch and two position blade indicator switch. Provide factory mounted end switch Ruskin Model SP-100 for all dampers.
- F. Smoke dampers for medium pressure duct applications shall be Ruskin Model SD-60 or approved equal by Greenheck, Air Balance, NCA, Pottorff or United Enertech. Smoke dampers for low pressure duct applications shall be Ruskin Model SD-36 or approved equal.
- G. Smoke isolation dampers at air handling unit discharge shall be Ruskin Model SD-102, UL555S, Class 2 or approved equal.

- H. Smoke isolation dampers for return fan/unit inlet locations shall be Ruskin Model SD-60 or approved equal.

2.5 DUCT LINING

- A. Duct lining shall be provided as indicated as below and elsewhere as indicated on the drawings. Provide duct lining for the following:
 - 1. **AS INDICATED ON DRAWINGS FOR SUPPLY AND RETURN DUCTWORK.**
 - 2. **ALL TRANSFER DUCTWORK.**
- B. Duct lining shall be Armacell, AP Armaflex SA duct liner, or approved equal 1" thickness for low pressure systems, or as noted on plans.
- C. Adhere liner, with mat side toward air stream, to all interior sides of duct with 100% coverage. Where duct width exceeds 12" or height exceeds 16", further secure the liner to these surfaces with welding pin type mechanical fastener as shown in the SMACNA Duct Manual.
- D. Provide leading edge protection as indicated in SMACNA Duct Manual at beginning of each section of lined duct. Take every precaution to protect surface of liner as damaged liner will be rejected. Submit samples for approval of liner for each of the following: low and medium pressure installations and leading edge protection for each pressure classification. Liner installed without approval of samples and shop drawings shall be subject to removal as directed by the Architect and replacement shall be at no cost to the Owner.
- E. Duct sizes indicated on the drawings are air side sizes. Increase sheet metal sizes accordingly to compensate for thickness of lining.

2.6 DUCT ACOUSTICAL SOUND LAGGING

- A. Acoustical pipe and duct lagging shall be a 1 lb psf vinyl noise barrier with a reinforced foil facing on one side bonded to a 2" thick acoustical fiberglass quilted with a nonporous scrim facing.
- B. Acoustical sound lagging shall be provided on the exterior of ductwork where indicated on the drawings.
- C. Product shall be installed ductwork inside the building between the connection to the air handling equipment and the first sound attenuator to reduce break-out noise within the occupied space.
- D. Acoustical sound lagging shall be equal to Sound Seal Model B-10 LAG/QFA-9
- E. Fiberglass insulation shall be nominally 2" thick with density of 2.0 lb/cu. Ft.
- F. Acoustical:
 - 1. Sound Transmission Class (STC) rating shall be minimum of 30.
- G. Flammability: Maximum flame spread index of 12.6 and maximum smoke density index of 19.6.

- H. Install acoustical pipe and duct lagging in locations indicated. Comply with manufacturers written instructions for installation by using type of mounting accessories indicated or, if not indicated, as recommended by the manufacturer.

2.7 DUCTWORK

A. General

1. The Duct Manual as herein referenced shall mean the SMACNA manual as published by the Sheet Metal and Air Conditioning Contractors National Association, Inc.
2. Unless noted otherwise, ductwork shall be constructed of prime, first quality galvanized steel of gauges as called for in the Duct Manual. Reinforce all ducts to prevent buckling, breathing, vibrations, or unnecessary noise. Such reinforcing shall be as recommended in Duct Manual, plus any additional reinforcing as required to meet job conditions. Longitudinal and cross joints, elbows, transitions, etc, shall be furnished as specified in Duct Manual, including recommended duct supports to suit job conditions.
3. All uninsulated rectangular ductwork shall be crossbroken on all four sides of each panel section. All vertical and horizontal sheet metal barriers, duct offsets and elbows, as well as the panels of straight sections of ducts, shall be crossbroken. Crossbreaking shall be applied between the standing seams or reinforcing angles. The center of the crossbreak shall be of the required height to assure each panel section being rigid, to prevent vibrations and "breathing."
4. Prior to fabrication of any ductwork, Contractor shall submit to the Architect for approval shop drawings and data for each duct system which shall describe for each duct, the size, gauge, material, joint type, seam type, and reinforcement to be provided. All construction shall be in accordance with the requirements hereinafter specified. No ductwork shall be fabricated or installed until the details of construction are submitted and approved. Ductwork installed at variance to these conditions shall be subject to removal and replacement at no cost to the Owner.
5. Provide 22 gauge galvanized sleeve around ducts passing through drywall construction.
6. Provide 22 gauge aluminum flanged trim collar and sleeve around exposed ducts through walls, floor or ceilings in finished areas to provide finished appearance.

B. Low Pressure Ductwork-[Less Than 2" Pressure Class]

1. Ductwork shall conform with requirements and details, unless specified or indicated otherwise in the Duct Manual, "HVAC Duct Construction Standards, Metal and Flexible," 2005 with all addenda. A copy of the Duct Manual shall be secured by the Contractor and shall be kept at the project for convenient reference.
2. Flexible duct connections at air handling unit connections, where indicated or required to eliminate duct vibration shall be "Ventglass" duct fabric as manufactured by Ventfabrics, Inc., or approved equal.
3. Except as noted herein under "Medium Pressure Ductwork," all ductwork including supply air, outside air, return air, and exhaust air provided on the project shall be low pressure construction. Rectangular low pressure ductwork construction shall conform to the following SMACNA Standards:

1.	Material gauges	Refer to the "Duct Construction Schedule" on the drawings.
2.	Longitudinal Seams	Fig. 2-2, Types L-1, L-2 & L-4
3.	Corner Closures	Fig. 2-14, 2-15, 2-17 & 2-18
4.	Hangers	Fig. 5-1, 5-2, & 5-5 & Tables 5-1 & 5-2
5.	Rectangular Elbows	Fig. 4-2, Types RE-1 & RE-2
6.	Vaned Elbows (Applies to RE-2 type)	Fig. 4-3 & 4-4, Runner Type 1 to have a vane at each tab
7.	Offsets & Transitions	Fig. 4-7
8.	Branch Connections	Fig. 4-6, 45° or conical only
9.	Volume dampers (up to and including 12" deep)	Fig. 7-4, Figs. A&B w/locking quadrant
10.	Volume dampers (over 12" deep)	Fig. 7-5 w/locking quadrant
11.	Access doors	Minimum 12"x12" unless otherwise noted. Provide Ventlock w/#140 latch, insulated or approved equal
-
4. Duct sizes indicated on the drawings are air side sizes. Where duct lining is indicated, increase sheet metal sizes accordingly to compensate for thickness of lining. Duct lining shall conform to paragraph 2.4 of this section.
 5. Seal all traverse joints and fittings in all low pressure supply, return, and exhaust ductwork and reheat coil connections to supply air terminal units with United Duct Sealer. At contractor's option, mineral impregnated woven fiber tape as manufactured by Hardcast, Inc. shall be considered equal.
 6. Provide Elgen Model E115, E116, or E117 low leakage or approved equal quadrant on all volume dampers.
 7. Provide stand-offs, on volume dampers installed in all insulated ductwork. Depths of stand-offs shall exceed thickness of specified insulation to provide sufficient operating clearances.
 8. Flexible ductwork shall be Hart & Cooley Type F-116 or approved equal. Flexible duct shall comply with NFPA Bulletin 90A and shall be U.L. listed as Class 1 Air Duct & Connector, Standard 181. Flexible duct shall be approved and suitable for installation in ceiling return air plenums.
 9. Provide Conical Fittings with integral volume damper, at flexible duct connections to sheet metal duct. Seal all fittings to sheet metal duct with United Duct Sealer.

10. Support all ducts in accordance with Duct Manual, Tables 5-1 & 5-2 and as hereinbefore specified and as indicated and noted on the drawings.

C. Medium and High Pressure Ductwork-[Greater Than 2" Pressure Class]

1. Medium and high pressure ductwork shall be rated as indicated on the "Duct Construction Schedule" on the drawings.
2. Medium and high pressure ductwork shall consist of rectangular, circular and flat oval types as indicated on the drawings. At contractor's option, rectangular ductwork may be substituted for flat oval or circular type. Equivalent flat oval or circular sizes to rectangular sizes shall be maintained. Submit rectangular duct sizes for approval.
3. Ductwork, other than medium or high pressure type specified herein, including supply, return, relief, outdoor air, and exhaust shall be low pressure ductwork.
4. All medium and high pressure duct systems shall be leak tested in strict conformance with SMACNA standards. Tests shall be witnessed by the balance subcontractor as hereinafter specified.
5. Rectangular medium or high pressure ductwork, unless otherwise specified herein, shall conform with the requirements and details contained in the Duct Manual, "HVAC Duct Construction Standards, Metal and Flexible," 2005 with all addenda hereinafter referred to as "Duct Manual." A copy of the Duct Manual shall be secured by the Contractor and shall be kept at the project for convenient reference. Construction shall conform to the following:

1. Reinforcement & Gauges	Refer to the "Duct Construction Schedule" on the drawings.
2. Traverse Joints	Table 2-32, Figs. T-22, 2-2, T-24 & T-24a
3. Longitudinal Joints	Figs. #2-2, L-1 and L-3
4. Vanes and Vane Runners	Fig. #4-3 & 4-4 Runner Type-1 to have a vane at each tab
5. Branch Connections	Fig. #4-6 45° only
6. Offsets & Transitions	Fig. #4-7
7. Supporting Systems	Fig. #5-5 Trapeze type only, Tables 5-1 & 5-2
8. Riser Supports	Fig. #5-8 Fig B
9. Volume Dampers	Ruskin CD-60 Airfoil
10. Duct Sealants	See Pages 1-11 through 1-13. Use 3 3M EC-750 or approved equal, on seams & joints

11. Access Doors	Ruskin or approved equal minimum 12" x 12", with cam lock latches, insulated
12. Welded galvanized	Coated with minimum two coats of corrosion resistant aluminum paint

D. Circular Medium Pressure Ductwork:

1. Circular medium pressure ductwork shall be manufactured by McGill AirFlow, Semco, Lindab Safe, Sheet Metal Connectors, Inc., TNT Manufacturing, Inc., MKT Metals, or Eastern Sheet Metal and shall consist of spiral pipe and welded fittings that shall be factory painted. Circular duct shall have locked seams so made as to eliminate any leakage under the pressures for which the system has been designed. Longitudinal seam duct shall have fusion welded butt seam. All welded seams shall be factory painted. Circular duct shall be manufactured of galvanized steel meeting ASTM A-527-80 by the spiral lockseam method and in the minimum gauges listed:
 - a. For systems operating at 2.0" W.G. or less positive pressure the minimum gauges shall be as follows:

<u>Diameter</u>	<u>Spiral Seam</u>	<u>Longitudinal</u>
<u>Seam</u>		
- 8"	28	26
- 14"	28	26
- 26"	26	24
- 36"	24	22
- 50"	22	20
- 60"	20	18
- 84"	N.A.	16

- b. For systems operating at up to 10.0" W.G. or less positive pressure the minimum gauges shall be as follows:

<u>Diameter</u>	<u>Spiral Seam</u>	<u>Longitudinal</u>
<u>Seam</u>		
- 8"	26	24
- 14"	26	24
- 26"	24	22
- 36"	22	20
- 50"	20	20
- 60"	18	18
- 84"	N.A.	16

- c. For systems operating between 0.0" and 2.0" W.G. negative the minimum gauges shall be as follows:

<u>Diameter</u> <u>Seam</u>	<u>Spiral Seam</u>	<u>Longitudinal</u>
- 8"	28	24
- 14"	26	24
- 26"	24	22
- 36"	22	20
- 50"	20	18
- 60"	18	16
- 84"	N.A.	14

2. All fittings are to have continuous welds along all seams. All welded seams shall be factory painted. All divided flow fittings are to be manufactured as separate fittings, not as tap collars welded into spiral duct sections. Fittings and couplings shall be of the following minimum gauges:

<u>Diameter</u>	<u>Minimum Gauge</u>
Through 14"	24
Through 26"	22
Through 50"	20
Through 60"	18
Through 84"	16

3. All 90 degree tees and 45 degree laterals, either full size or reducing shall be conical pattern produced by machine or press forming. The entrance shall be free of weld build-up, burrs, or irregularities. Provide tangential tees where indicated and as required to suit the installation.
4. Elbow diameters 3" through 8" shall be two section die-stamped elbows. All other elbows shall be gored construction with all seams continuous-welded and painted. Elbows shall be fabricated in a centerline radius of 1.5 times the cross section diameter. All elbows not die-stamped shall be fabricated according to the following schedule:

<u>Elbow Angle</u>	<u>No. of Gores</u>
Less than 30°	2
30° through 60°	3
Over 60°	5

5. The reduction of divided flow fittings shall be conical spun section in the thirty-six reductions in sizes 4" through 22".
6. Offset fitting shall be constructed so that length is not less than 2 duct diameters.

7. Galvanized areas that have been damaged by welding shall be coated with corrosion resistant aluminum paint, minimum 2 coats.
8. Supports, sealants and testing shall conform with applicable portions of the Duct Manual and as hereinbefore specified.
9. Flexible ductwork in medium pressure duct systems shall be Hart & Cooley Genflex Type SLR-25VM or approved equal.
10. Dampers in circular M.P. duct systems shall be Ruskin Model CDR 92 or approved equal with locking type quadrant.
11. Seal all transverse joints, longitudinal seams and duct wall penetrations in medium and high pressure ductwork in accordance with duct sealing requirements of the "Duct Construction Manual".

2.8 AIR MEASURING DEVICES

- A. Provide air measuring stations and transmitters in the ductwork of the sizes and capacities indicated on the drawings. Refer to automatic temperature control diagrams and contract drawings for size and type.
- B. Devices shall be as manufactured by Ebtron Gold Series or Tek-Air compatible with the variable air volume (VAV) system sequences, or as indicated on the contract documents, or approved equal. Flow station transmitters shall be field selectable, fuse protected and isolated 0-10 VDC and 4-20 MA (4 wire) signal. System accuracy shall be within 3% of reading.
- C. Ebtron sensor housings shall be mounted in an extruded, gold anodized, 6063 aluminum tube probe assembly.
- D. Each station shall be installed with minimum upstream and downstream clearances in accordance with the manufacturer's printed instruction.
- E. Air measuring devices installed at fan inlets shall be equal to Ebtron GTX116F.
- F. Transmitters shall be microprocessor based with LED display, or approved equal.

2.9 SOUND ATTENUATORS

- A. Provide Industrial Acoustics Company, Vibro-Acoustics, Semco, Dynasonics, McGill AirFlow, Price, or Ruskin Sound Control sound attenuators as scheduled on the drawings and herein specified. Outer casings of attenuators shall be made of 22 gauge galvanized steel. Seams shall be lock formed and mastic filled.
- B. Interior partitions for rectangular attenuators shall be made of 24 gauge galvanized perforated steel. Filler material shall be of inorganic mineral or glass fiber of a density sufficient to obtain the specified acoustic performance and packed under not less than 5% compression to eliminate voids due to vibration and settling. Material shall be inert, vermin and moisture proof. Combustion rating for the attenuator acoustic fill shall be not less than the following, when tested in accordance with ASTM E-84, NFPA Standard 255 or U.L. No. 723:
 1. Flamespread Classification 20
 2. Smoke Development Rating 20

3. Fuel Contributed 15

2.10 AUTOMATIC CONTROL DAMPERS

- A. Dampers shall be factory fabricated and shall have flow control characteristics required by each individual application. For modulating dampers under actual operating conditions, provide type which produces a linear relationship between air flow and operating range.
- B. Include on submittal data information which will establish suitability of dampers proposed (sizes and types), show inherent flow characteristics of the various types of dampers (individual and combination) for each application required for the project. Also furnish certified data on damper leakage rate and operator power criteria.
- C. Dampers, when closed, shall not leak in excess of 3 cfm per square foot at 1-inch water gage static pressure differential and be so certified by the manufacturer Class 1A. Furnish damper operators having sufficient power to limit leakage to the rate specified.
- D. Dampers shall be galvanized, low leakage, with airfoil blades. Frames shall be 5" x 1" x 1/8" extruded aluminum or aluminum hat channel with hat mounting flanges on both sides of the frame. Each corner shall be reinforced with two die-formed internal braces. Blade edge seals shall be extruded vinyl double edge design and shall be locked in extruded blade slots without use of cement. Bearings shall be non-corrosive two piece molded synthetic. Axles shall be square or hexagonal to provide positive connection to blades and linkages.
- E. All dampers shall have neoprene damper seals at all blade edges and ends suitable for an operating range down to 0°F at the lower end and 200°F at the upper end.
- F. Where rectangular dampers are twelve (12) inches or more in a direction perpendicular to the axis, use sectionalized type with blade width not exceeding eight (8) inches. Where rectangular damper is larger than four (4) square feet in area, use corner braces. Blade length is not to exceed forty-eight (48) inches.
- G. Operating link, i.e. connection rods transmitting motion from damper motors to damper, shall be sized to withstand a load equal to at least twice the maximum damper operating force without deflection. Make lengths adjustable and construct of brass, bronze or steel. For zinc-coated or cadmium plated steel links, construct working part of joints, e.g. clevises, and ball-and-socket joints of bronze or stainless steel.
- H. Provide for adjustment for blade travel in either direction. Control the open and closed position of pneumatic operated dampers by controlling the stroke of motor by adjustment stops or by adjustment of crank arm.
- I. Factory finish parts of steel damper with two coats of rust inhibitive paint.
- J. Dampers shall be Ruskin or approved equal by TAMCO Series 1500, or Pottorff Model CD, scheduled as follows:
 - 1. Control dampers shall be galvanized steel construction - CD 60..

2. Isolation dampers (high pressure fan discharge application) shall be galvanized construction - CD-80 AF-1.
3. Shutoff dampers for outdoor air intake and exhaust openings shall be Class 1 and have leakage rate no greater than 4 cfm per square foot at 1.0 inch water gauge and labeled in accordance with AMCA 500D.

PART 3 - EXECUTION

3.1 AIR DEVICES

- A. Install air devices in accordance with the manufacturer's latest published installation instructions to insure against incorrect air pattern, drafts, and dirt smudging.
- B. Construct, and install sheet metal duct or plenum connections to air devices in accordance with manufacturer's recommendations.
- C. Make modifications of duct systems required to accommodate actual sizes of air devices furnished, e.g. transformations and collar sizes, without additional cost.

Coordinate installation of air devices with architectural reflected ceiling plan. Unless otherwise indicated on the RCP install air devices in the center of ceiling tiles.

3.2 FIRE DAMPERS, SMOKE DAMPERS, AND COMBINATION FIRE/SMOKE DAMPERS

- A. All fire dampers, smoke dampers, and combination fire/smoke dampers shall be tested upon installation, and at a period of one year after project completion. Contractor shall inspect, test and provide a written report documenting the testing procedure prior to the expiration date of the one year warranty. Any dampers failing inspection shall be repaired/replaced at no additional cost to the owner.
- B. The dampers shall be tested in accordance with NFPA 80 and 105, and Joint Commission Standard EC.02.03.05 EP18. Per NFPA 80, dampers shall be tested and operation documented after installation. Each damper must be numbered and tested. The installing or testing contractor shall request a test sheet with available device numbers from the Facilities Department. Each electrical device shall be operated locally and closure verified. The printed report from the fire alarm system shall be provided to indicate the operation of the initiating device. Each gravity fire alarm system shall be provided to indicate the operation of the initiating device. Each gravity fire link shall be released and damper closure verified. The device shall be logged on the test sheet with the initials of the tester, type of device, location, and date of test. All testing shall be in the presence of a witness from the Facilities Department and the commissioning agent.

3.3 DUCTWORK

- A. Install hangers, supports, and their attachments, generally, in conformance with SMACNA standards referred to in this section of the specifications.

- B. Furnish hangers capable of withstanding 5 times the weight of the load imposed on them without Damage to duct or any adjacent construction.
- C. Neatly erect ducts and plenums of sizes and arrangements shown and detailed and as required to carry out intent of specifications and drawings. Work must meet approval of the Architect in all its parts and details.
- D. Sizes shown are air side sizes. Where ducts are indicated as lined, dimensions shall be increased to reflect the thickness of the lining.
- E. Install ductwork in such a manner as to meet recommendations of NFPA Standard 90A.
- F. Contractor shall review and coordinate the installation of the ductwork. No ductwork shall be fabricated prior to the contractor obtaining exact field dimensions of the building structure, including new and existing ceiling space conditions, architectural, mechanical, electrical, and structural obstructions, etc, which may affect the installation of the air distribution system. Notify the Architect immediately upon any discrepancies.
- G. Because of the small scale of the drawings, it is not possible to indicate all duct offsets, rises, drops, fittings and accessories which may be required. Carefully investigate in the field the architectural, mechanical, electrical, and structural conditions affecting the work, and arrange such work accordingly, providing such fittings, and accessories as may be required to meet such conditions.
- H. Provide each air outlet with a collar adequately stiffened, fastened, and made suitable for securing air device thereto. Make field changes in ductwork, such as those required to accommodate the sizes of factory fabricated equipment actually furnished, i.e., VAV terminal units, coils, fans, filter housings, and similar items, without additional cost. Provide duct flanges to match those of connecting factory fabricated equipment. When necessary, relocate and modify ductwork to avoid obstructions such as structural members, piping and conduit, in a manner acceptable to the Architect.
- I. Construct and install all ductwork in accordance with the SMACNA Standard specified.
- J. Leak Testing of Ductwork:
 - 1. Low Pressure System: Test all low pressure ductwork (pressure class less than 2" w.g.), scheduled for Seal Class A or B. Leakage testing shall be performed on 100% of the installed ductwork except for downstream of terminal units.
Random testing of low pressure ductwork, downstream of all terminal units shall be required if duct sealing appears inadequate. Testing methodology shall be in accordance with SMACNA's "HVAC Air Duct Leakage Test Manual". Refer to the duct construction schedule on the drawings for additional information.

Allowable Leakage shall be determined by the following formula:

$$F = C_L \times P^{0.65}$$

F = Leakage (CFM/100 ft² of duct

surface
 $C_L = 12$ (rectangular ductwork)
 $C_L = 6$ (round ductwork)
 $C_L = 4$ (all ductwork located outdoors)
 $P =$ Duct Leakage Test Pressure (in.
w.g.)

Keep ducts free of audible leaks which are detectable in all finished spaces.
Notify testing and balancing contractor who shall witness tests, at least 48 hours
in advance of tests.

2. Medium Pressure System: Test all ductwork with a pressure class of 2" w.g. or greater. Leakage testing shall be performed on 100% of the installed ductwork. Testing methodology shall be in accordance with SMACNA's "HVAC Air Duct Leakage Test Manual." Refer to the duct construction schedule on the drawings for additional information.

Allowable Leakage shall be determined by the following formula:

$$F = C_L \times P^{0.65}$$

$F =$ Leakage (CFM/100 ft² of duct
surface)
 $C_L = 12$ (rectangular ductwork)
 $C_L = 6$ (round ductwork)
 $C_L = 4$ (all ductwork located outdoors)
 $P =$ Duct Leakage Test Pressure (in.
w.g.)

Keep ducts free of audible leaks which are detectable in all finished spaces.
Notify testing and balancing contractor who shall witness tests, at least 48 hours
in advance of tests.

K. Cleaning:

1. Clean the inside of ductwork and casing of debris, dirt, and other foreign matter before any system's fans and filters are operated for any reason. After the equipment has been used temporarily for any purpose, i.e., adjusting, testing and ventilating, clean or renew (depending on type) filter media and clean ducts downstream from the filters which have handled unfiltered air. Additionally, clean exhaust and return ducts, which in the opinion of the Architect, have been handling excessive dirty air prior to acceptance of the system.
2. Keep main duct risers capped with plastic or poly after duct testing to help maintain clean risers. Provide roll filter media at each open end duct to help maintain clean risers until project balancing begins.

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SECTION 23 34 00

FANS AND VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 of specifications sections, apply this section.

1.2 SUMMARY

- A. This section includes:

- 1. Fans
- 2. Ventilators

1.3 COMMISSIONING

- A. Division 23 will be responsible to carry out the commissioning requirements specified in Section 23 00 10, and 23 08 00.

1.4 SUBMITTALS

- A. Submit shop drawings for all materials specified in this section in accordance with section 23 00 50.
 - 1. Include construction details, material descriptions, dimensions of individual components, and finishes for the product.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Include plans, elevations, sections, and mounting or attachment details.
 - 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 4. Include diagrams for power, signal, and control wiring.
 - 5. Operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 Fans

- A. General

- 1. Provide fans having a certified rating based on tests performed in accordance with AMCA Bulletins Number 210, 211A and 300. See AMCA Standard 99 "Standard Handbook" for definitions of fan terminology. Arrangement, size and capacity of fans are indicated on the drawings.
- 2. All fans shall be statically and dynamically balanced by the manufacturer. Field mounted vibration isolation units as hereinbefore specified shall be installed on each fan.
- 3. Diffuser cones and inlet bells are not permitted in rating a fan unless they are an integral part of the fan design. Additionally, where applicable, fans shall not be rated for air-over (AO) duty.

4. Provide inlets and outlets of fans not duct connected, including fans in plenum chambers or open to outside, with heavy guard screens to protect personnel. Construct guard screens in a manner that will not impair fan performance, and when bolted to equipment will permit their removal for fan service and cleaning.
5. Provide lubrication facilities, such as oil reservoirs, sight glasses, grease and relief fittings, fill and drain plugs, pipe connections, etc. Place in a readily and safely accessible location so that after installation they will perform required function without requiring the dismantling of any parts or stopping equipment.
6. All parts of fans shall be protected against corrosion prior to operation of the fan.
7. Certified performance data including acoustical data shall be submitted for each fan at design conditions. Data shall include published sound power levels based on actual test on the fan sizes being furnished, and conducted in accordance with current, AMCA Standards. Such data shall define Sound Power Levels (PWL), re: 10-12 watts for each of the eight frequency bands. Sound Power Levels shall not exceed those scheduled. Should additional attenuation be required to achieve the levels specified, it shall be included by the fan manufacturer. Any cost of field modifications necessitated by additional attenuation shall be so included by the fan manufacturer. Fan curves shall be submitted which will depict static pressure, total pressure, brake horsepower, and mechanical efficiency plotted against air volume. Data submitted in tabular form is not acceptable.
8. Motors, drives, curbs, and bases shall be furnished by the fan manufacturer in accordance with the requirements of Section 23 00 10. Note potential drive change requirements for motors 20 HP and above.

B. Domed Exhaust Ventilators (Type "H")

1. Domed centrifugal power roof ventilators shall be Acme Engineering Inc., Loren Cook, or JENco, equal to Greenheck Model GB or G as scheduled.
2. The fan housing shall be constructed of heavy gauge aluminum with a rigid internal support structure. The fan shroud shall have a rolled bead for added strength.
3. Fan wheels shall be of the centrifugal backward curved non-overloading design, direct or V-belt drive as scheduled. Fan wheel and fan housing shall be of heavy gauge all aluminum construction, with motor and drive assembly located out of exhaust airstream in separate compartment that is forced air cooled with outside air. All exposed fasteners shall be stainless steel.
4. Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearing shall be selected for a minimum of (L50) life in excess of 200,000 hours at maximum cataloged operating speed. Drives shall be sized for a minimum of 150% of driven horsepower.
5. Motors shall be in accordance with Section 230010 of these Specifications. Single-phase direct drive fans, unless for explosion proof application, shall have solid-state speed controller, factory mounted in motor compartment and factory wired to fan motor.
6. All fans shall be provided with birdscreen, factory-wired safety switch and automatic backdraft damper. Prefabricated roof curbs shall be fully welded galvanized steel, 12" high, with insulation, wood nailer, and cant. For pitched roofs, curbs shall be constructed to match roof pitch. Where acoustical curbs are indicated on the plans, curbs shall be 16" high with vertical sound absorbing baffles in a removable galvanized framework.
7. All fans shall carry AMCA Certified Rating Seal for Air and Sound performance. All fans shall be provided with birdscreen, and 24V motorized backdraft damper. Damper shall be wired to auxiliary contact on ECM motor. Prefabricated roof curbs shall be fully welded aluminum, 12" high, with insulation, wood nailer, and cant for pitched roofs, curbs shall be constructed to match roof pitch where acoustical curbs are indicated on plans, curbs shall be 16" high with vertical sound-absorbing baffles in a removable galvanized framework.

C. Inline Centrifugal Cabinet Fan: (Type "L")

1. Inline centrifugal cabinet fans shall be Greenheck Model BSQ, as scheduled on plans, or equal by Twin City, Loren Cook, or Acme.
2. The fan housing shall be of the square design with square duct mounting collars.
3. The fan wheel shall be centrifugal backward inclined, constructed of aluminum, V-belt drive. Fan wheel and fan housing shall be of heavy gauge construction, with motor located out of exhaust airstream.
4. Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearings shall be selected for a minimum (L50) life in excess of 200,000 hours at maximum cataloged operating speed. Drives shall be sized for minimum of 150% of driven horsepower.
5. Motors shall be in accordance with Section 230010 of these Specifications. Single phase direct drive fans, unless for explosion proof application, shall have solid state speed controller, factory mounted in motor compartment and factory wired to fan motor.
6. All fans shall carry AMCA Certified Rating Seal for Air and Sound performance. All fans shall be provided with birdscreen and 24 V motorized backdraft damper.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fans level and plumb.
- B. Install fans with clearances for service and maintenance.

3.2 FIELD QUALITY CONTROL

- A. Test and inspect components, assemblies, and equipment installations, including connections.
- B. Verify that shipping, blocking, and bracing are removed.
- C. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
- D. Verify that cleaning and adjusting are complete.
- E. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
- F. Adjust belt tension.
- G. Adjust damper linkages for proper damper operation.
- H. Verify lubrication for bearings and other moving parts.
- I. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
- J. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.

- K. Shut unit down and reconnect automatic temperature-control operators.
- L. Remove and replace malfunctioning units and retest as specified above.
- M. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.
- N. Adjust damper linkages for proper damper operation.
- O. Adjust belt tension.
- P. Lubricate bearings.

END OF SECTION 23 34 00

SECTION 23 36 00

AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes specifications for the following equipment:
 - 1. Air Terminal Units

1.3 COMMISSIONING

- A. Division 23 will be responsible to carry out the commissioning requirements specified in Section 23 00 10 and 23 08 00.

1.4 SUBMITTALS

- A. Submit shop drawings for all materials specified in this section in accordance with section 23 00 50.
 - 1. Include construction details, material descriptions, dimensions of individual components and finishes for the product.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, methods of field assembly, components, and location and size of each field connection.
 - 4. Include diagrams of power, signal and control wiring.
 - 5. Operation and maintenance manuals.

1.5 WARRANTY

- A. Provide 5-year extended manufacturer warranty.
- B. The warranty period shall start at the date of overall substantial completion for the project.
- C. Mechanical equipment shall not be used during construction. Contractor shall provide temporary heat/cooling/dehumidification as required, without using the Owner's permanent HVAC equipment.
- D. Submit a sample warranty for approval before purchasing equipment.

- E. See section 01 77 00 – Closeout Procedures for additional warranty requirements.

PART 2 - PRODUCTS

2.1 VARIABLE AIR VOLUME CONTROL UNITS

- A. Provide low pressure variable air volume control units as indicated on the plans.
- B. Type "VSD" Unit (Digital)
1. Units shall be Titus, Enviro Tec, Johnson Controls, Krueger, Nailor, or Price, equal to Price SDVQ, suitable for single duct variable air volume installation. Capacities shall be as scheduled on the drawings.
 2. The unit casing shall be minimum 22 gauge galvanized steel with a steel bladed damper. All seams shall be factory sealed to prevent leakage.
 3. The terminals shall have an approved non-porous EPFI sealed liner. The liner and insulation must meet the requirements of U.L. 181 and NFPA 90A. The liner must meet bacteriological standards of ASTM C665. Liners made of Tedlar, Mylar, Silane or Alpha-Temp are not acceptable. Insulation shall be 1.5 pound density, 1/2 inch thick with a thermal conductivity of 0.5 BTU-in/hr-ft². The lining shall be the Price Fiber Free Foam Liner system or approved equal.
 4. **Where scheduled, units shall be provided with integral three foot discharge sound attenuator, equal to Price ATT.**
 5. The unit inlet shall be equipped with a cross-shaped flow sensor with amplifying pick-up points connected to central averaging chambers. The sensor shall maintain control accuracy with the inlet duct in any configuration. All pneumatic tubing shall be UL listed, fire retardant (FR) type.
 6. Sound ratings shall be tested as power levels to 10-12 watts and shall not exceed values scheduled. The manufacturer shall furnish certified sound power levels for both discharge sound and casing radiated sound, tested in accordance with ASHRAE Standard 37-72. Sound data based on prior ASHRAE Standards will not be acceptable. The tests shall be conducted in an ARI-ADC approved sound facility. The data shall include the second through sixth octave bands for all unit sizes with multiple inlet static pressures. All attenuation factors shall be clearly defined. Provide additional approved attenuation as required to achieve the scheduled values. Sound power levels shall be submitted for each unit at its scheduled maximum air volume and inlet pressure of 1" w.g.
 7. The direct digital controls (DDC) shall be provided by the automatic temperature control contractor. Controller shall be shipped to terminal unit manufacturer for factory mounting. The terminal unit manufacturer shall mount the electronic damper actuator and velocity flow sensor. Refer to Section 23 09 00 for additional requirements. The damper actuator shall apply at least 40 in-lbs of torque to the damper shaft. Electronic actuators shall be provided by the automatic temperature control contractor.
 8. Hot water coil shall be provided with unit where scheduled. Coil shall be constructed of aluminum fins mechanically bonded to copper tubes. Coils shall be designed for minimum working pressure of 150 psig and shall be air tested under water at minimum 250 psig. Coil capacity shall be as scheduled and shall be ARI certified.
 9. Provide bottom access door, upstream of the reheat coil. Access door shall be minimum 5"x5" access door with cam lock fasteners.

10. Device shall be provided with a 120V to 24VAC Class 2 transformer and NEMA-1 disconnect factory mounted in NEMA-1 steel enclosure and shall be certified to UL873 Temperature and Regulating Equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. VAV Terminal Units

1. Install terminal units in accordance with details shown on the drawings. Provide all necessary supports as indicated and required. Locate units to provide full accessibility to all damper operators, controllers and accessories.

3.2 START-UP/COMMISSIONING

- A. Start-up shall include verifying proper installation, testing all valves & set points
- B. TAB (Test and Balance) contractor shall be responsible for final verification of airflow measurement.

END OF SECTION 23 36 00

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SECTION 23 52 16
CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes packaged, factory-fabricated and -assembled, gas-fired, fire-tube combustion condensing boilers, trim, and accessories for generating hot water.

1.3 ACTION SUBMITTALS

- A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Source quality-control test reports.
- B. Field quality-control test reports.
- C. Efficiency Data Points: Data shall be submitted per ASHRAE 155 Method of Testing for Rating Commercial Space Heating Boiler Systems. This data shall cover steady state thermal efficiency, part load efficiency, and idling energy input rate. Efficiency data not supported by a third party published test standard shall not be permitted.
- D. Warranty: Special warranty specified in this Section.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
- C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- D. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Pulse-Combustion Boilers:
 - a. Heat Exchanger, Pressure Vessel and Condensation Collection Basin shall carry a 10 year limited warranty against defects in materials or workmanship.
 - b. Heat exchangers/pressure vessel are warranted against thermal shock for the lifetime of the boiler.
 - c. The burner shall carry a five (5) year limited warranty against defective material or workmanship from the date of shipment.
 - d. All other components shall carry a five year warranty.
 - e. The warranty period shall start at the date of overall substantial completion for the project.
 - f. MECHANICAL EQUIPMENT SHALL NOT BE USED DURING CONSTRUCTION. CONTRACTOR SHALL PROVIDE TEMPORARY HEAT/COOLING/DEHUMIDIFICATION AS REQUIRED, WITHOUT USING THE OWNER'S PERMANENT HVAC EQUIPMENT.
 - g. Submit a sample warranty for approval before purchasing equipment.
 - h. See section 01 77 00 – Closeout Procedures for additional warranty requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Lochinvar
 2. Harsco Industrial: Patterson Kelly
 3. Fulton

2.2 FIRE-TUBE CONDENSING BOILERS

- A. Description: Boiler shall be natural gas fired, fully condensing, and fire tube design. The boiler shall be factory-fabricated, factory-assembled, and factory-tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls.
- B. Heat Exchanger: The heater exchanger shall bear the ASME "H" stamp for 160 psi working pressure and shall be National Board listed. The heat exchanger shall be constructed of a fully welded 316L stainless steel interior with a carbon steel shell and of fire tube design. Fire tube shall be of the Wave Fire Tube design and capable of transferring 16,000 to 20,000 Btu's per tube. The Wave Fire Tube shall be manufactured via a liquid impact process. The Wave Fire Tube shall have an OD = 1.654" and a wall thickness = 0.039". The top and bottom tubesheets shall have a minimum thickness = 1/4" (0751-2001) or 3/8" (2501,6001). There shall be no overlapping welds with the Wave Fire Tube to tubesheet welds. The heat exchanger shall be designed for a single-pass water flow to limit the water side pressure drop. There shall be no banding material, bolts, gaskets or "O" rings in the heat exchanger design. Cast iron, aluminum, or copper tube or water tube boilers will not be accepted.
- C. Condensate Collection Basin: Fully welded 316L stainless steel.
- D. Intake Filter and Dirty Filter Switch: Boiler shall include an intake air filter with a factory installed air pressure switch. The pressure switch will alert the end user on the screen of the boiler that the intake filter is dirty and needs to be changed.
- E. Pressure Vessel: The pressure vessel shall be in accordance with ASME Section IV pressure vessel code. The pressure vessel shall be designed for a single-pass water flow to limit the water side pressure drop. Pressure drop shall be no greater than 6.5 psi at 180 gpm. The pressure vessel shall contain a volume of water no less than 94 gallons.
- F. Burner: Natural gas, forced draft single burner premix design. Operation of the burner shall not exceed that of 5.7% oxygen level or 40% excess air. The burner shall be high temperature stainless steel with a woven Fecralloy outer covering to provide modulating firing rates. The burner shall be capable of the stated gas train turndown without loss of combustion efficiency. The burner shall be removable from the boiler without removing the gas/air manifold. The burner shall have an independent

laboratory rating for Oxides of Nitrogen (NO_x) to meet requirements of South Coast Air Quality Management District (SCAQMD) as compliant with Rule 1146.2 (FB 0751 – FB 2001), Bay Area Quality Management District as compliant with Regulation 9 Rule 7 (FB 2501 – FB 6001) and Texas Commission on Environmental Quality (FB 0751 – FB 2001) as being compliant with Section 117.465.

- G. Blower: Boiler shall be equipped with a pulse width modulating blower system to precisely control the fuel/air mixture to provide modulating boiler firing rates for maximum efficiency. The burner firing sequence of operation shall include pre-purge, firing, modulation, and post-purge operation.
1. Motors: Comply with requirements specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
 - a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- H. Gas Train: The boiler shall be supplied with two gas valves designed with negative pressure regulation and shall be capable of the following minimum turndowns:

INPUT MBH	TURNDOWN	MINIMUM INPUT	MAXIMUM INPUT
1250	20:1	62,500	1,250,000

- I. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision. Boilers using a pilot for ignition and/or UV scanners for flame supervision shall be deemed unacceptable.
- J. Casing:
1. Jacket: Sheet metal, with snap-in or interlocking closures.
 2. Control Compartment Enclosure: NEMA 250, Type 1A.
 3. Finish: Powder-coated protective finish.
 4. Insulation: Minimum 1/2-inch-thick, mineral-fiber insulation surrounding the heat exchanger.
 5. Combustion-Air Connections: Inlet and vent duct collars.
 6. Clearances: Boilers shall feature zero (0) clearance to combustibles. Boilers shall have the ability to be placed side by side in multiples with no clearance in between if necessary. Local codes should be considered.
- K. Venting
1. Direct Vent system of both the exhaust vent and combustion air. The flue shall be Category IV approved material constructed of Stainless Steel. A separate pipe shall supply combustion air directly to the boiler from the outside. The boiler's total combined air intake length shall not exceed 150 equivalent feet. The boiler's total combined exhaust venting length shall not exceed 150 equivalent feet.
 2. Vent shall be a product approved by the appliance manufacturer. For the basis of design Lochinvar Crest boilers, chimneys and vents shall be Simpson Duravent FasNSeal double wall system or approved equal.
 3. Duravent FasNSeal system shall be used for combustion air intake and vent.
 4. Inner Shell: AL29-4C stainless steel.
 5. Outer Jacket: 304 stainless steel.

6. The stack system shall be installed according to the manufacturer's installation instructions and shall comply with local codes or standards.
 7. The breeching and the stack shall be warranted against functional failure due to defects in material and manufacturer's workmanship for a period of ten years from date of delivery.
 8. Manufacturer's shop drawings showing the actual scaled layout shall be submitted to the Engineer for approval.
 9. The inner diameter or breeching and stack shall be verified by the manufacturer's computations.
 10. The system shall be UL Listed to UL 1738 and ULC S636.
 11. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
 12. Provide boiler adapter, flue termination, and intake air termination in accordance with the appliance manufacturer's recommendations
- L. Characteristics and Capacities: Refer to schedule on drawings for additional information
1. Heating Medium: Hot water.
 2. Design Water Pressure Rating: 150 psig.
 3. Safety Relief Valve Setting: 100 psig.
 4. Minimum Thermal Efficiency: 94 percent.

2.3 TRIM

- A. Aquastat Controllers: Operating, firing rate, and high limit.
- B. Safety Relief Valve: ASME rated.
- C. Pressure and Temperature Gage: Minimum 3-1/2-inch-diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.
- D. Boiler Air Vent: Manual.
- E. Drain Valve: Minimum NPS 3/4 hose-end gate valve.
- F. Condensate Trap: Factory supplied with condensate trip sensor.

2.4 CONTROLS

- A. Boiler operating controls shall include the following devices and features:
 1. 8" LCD screen display displaying status, modulation percentage, setpoints, and sensor data at a minimum on the home screen. Additional information such as history and parameters can be accessed via the touchscreen display without the need for navigation buttons. A screen saver mode shall be available with the display.

2. Variable Speed Boiler Pump Control: Boiler may be programmed to send a 0-10V DC output signal to an ECM or VFD boiler pump to maintain a designed temperature rise across the heat exchanger. The boiler shall be able to operate in this mode with a minimum temperature rise of 20 degrees F and a maximum temperature rise of 60 degrees F. Project specific temperature rise shall be 20 F
 3. Password Security: Boiler shall have a different password security code for the User and the Installer to access adjustable parameters.
 4. Outdoor air reset: Boiler shall calculate the set point using a field installed, factory supplied outdoor sensor and an adjustable reset curve.
 5. Pump exercise: Boiler shall energize any pump it controls for an adjustable time if the associated pump has been off for a time period of 24 hours.
 6. Ramp delay: Boiler may be programmed to limit the firing rate based on six limits steps and six time intervals.
 7. Boost function: Boiler may be programmed to automatically increase the set point a fixed number of degrees (adjustable by installer) if the setpoint has been continuously active for a set period of time (time adjustable by installer). This process will continue until the space heating demand ends
 8. PC port connection: Boiler shall have a PC port allowing the connection of PC boiler software.
 9. Time clock: Boiler shall have an internal time clock with the ability to time and date stamp lock-out codes and maintain records of runtime.
 10. Service reminder: Boiler shall have the ability to display a yellow colored service notification screen based upon months of installation, hours of operation, and number of boiler cycles. All notifications are adjustable by the installer.
 11. Three pump control: Boiler shall have the ability to control the boiler pump, system pump and the domestic hot water pump.
 12. Anti-cycling control: Boiler shall have the ability to set a time delay after a heating demand is satisfied allowing the boiler to block a new call for heat. The boiler will display an anti-cycling blocking on the screen until the time has elapsed or the water temperature drops below the anti-cycling differential parameter. The anti-cycling control parameter is adjustable by the installer.
 13. Night setback: Boiler may be programmed to reduce the space heating temperature set point during a certain time of the day.
 14. Freeze protection: Boiler shall turn on the boiler and system pumps when the boiler water temperature falls below 45 degrees. When the boiler water temperature falls below 37 degrees the boiler will automatically turn on. Boiler and pumps will turn off when the boiler water temperature rises above 43 degrees.
 15. Isolation valve control: Boiler shall have the ability to control a 2-way motorized control valve. Boiler shall also be able to force a fixed number of valves to always be energized regardless of the number of boilers that are firing.
 16. BMS integration with 0-10V DC input: The Control shall allow an option to Enable and control set point temperature or control firing rate by sending the boiler a 0-10V input signal.
 17. Data logging: Boiler shall have non-volatile data logging memory including last 10 lockouts, hours running and ignition attempts and should be able to view on boiler screen.
- B. The boiler shall have a built in Cascade controller to sequence and rotate lead boiler to ensure equal runtime while maintaining modulation of up to 8 boilers of different btu

inputs without utilization of an external controller. The factory installed, internal cascade controller shall include:

1. Lead lag: The Control module shall minimize the number of boilers firing to achieve the heating load.
2. Efficiency optimization: The Control module shall allow multiple boilers to fire at minimum firing rate in lieu of Lead/Lag.
3. Front end loading: The Control module shall have the ability to communicate with other Lochinvar boilers featuring the SmartTouch™ and Smart System™ control platforms. This allows for a combination of units that feature condensing and non-condensing operation if so desired.
4. Rotation of lead boiler: The Control module shall change the lead boiler every hour for the first 24 hours after initializing the Cascade. Following that, the leader will be changed once every 24 hours.
5. Redundancy: The Control module shall have a built in feature to continue operating with follow boilers if the Lead boiler is not operational.

C. Boiler operating controls shall include the following devices and features:

1. Set-Point Adjust: Set points shall be adjustable.
2. Operating Pressure Control: Factory wired and mounted to cycle burner.
3. Sequence of Operation: Factory installed controller to modulate burner firing rate to maintain system water temperature in response to call for heat.
4. Sequence of Operation: Electric, factory-fabricated and factory-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 10 deg F outside-air temperature, set supply-water temperature at 180 deg F; at 60 deg F outside-air temperature, set supply-water temperature at 140 deg F.

D. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

1. High Temperature Limit: Automatic and manual reset stops burner if operating conditions rise above maximum boiler design temperature. Limit switch to be manually reset on the control interface.
2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manually reset on the control interface.
3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
4. High and Low Gas Pressure Switches: Pressure switches shall prevent burner operation on low or high gas pressure. Pressure switches to be manually reset on the control interface.
5. Proof of Closure Valve (FB 6001 only): Proof of closure valve (POC) shall prevent the boiler from firing if the POC valve seat is detected open. Upon a call for heat, once the POC valve seat is proven to be closed, the pre-purge cycle will begin and the POC valve will begin to open.

6. Blocked Drain Switch: Blocked drain switch shall prevent burner operation when tripped. Switch to be manually reset on the control interface.
 7. Low air pressure switch: Pressure switches shall prevent burner operation on low air pressure. Switch to be manually reset on the control interface.
 8. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for any lockout conditions.
- E. Building Automation System Interface: Factory installed Modbus and BACnet MSTP gateway interface to enable building automation system to monitor, control, and display boiler status and alarms.
1. BACnet IP gateway shall be provided.
- F. Software Update: The control shall have the ability to receive updates in the field without hardware component replacement. This update can be performed via USB flash drive, internet connection, or via wireless connection. This service shall be provided at no additional and/or annual cost to the owner.
- G. CON•X•US Remote Connect: Integral remote connectivity technology that allows a mobile device to monitor and control boiler functionality. Internet connection is available on the Crest via Wi-Fi or hardwired Ethernet connection. This service shall be provided at no additional and/or annual cost to the owner.
- H. RealTime O₂ Feedback™: Boiler, if equipped with the optional RealTime O₂ Feedback™ package, shall provide real time sensing of O₂. Free air calibration of the sensor shall occur after every combustion cycle. The O₂ value shall also auto correct for conditions such as altitude. O₂ information shall be displayed in real time via a gauge on both the boiler touchscreen as well as the CON•X•US Remote Connect

2.5 ELECTRICAL POWER

- A. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

2.6 SOURCE QUALITY CONTROL

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
 - 1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

- A. Equipment Mounting: Install boilers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases specified in Section 03 30 00 "Cast-in-Place Concrete."
 - 1. Coordinate sizes and locations of concrete bases with actual equipment provided.
 - 2. Construct bases to withstand, without damage to equipment, seismic force required by code.
 - 3. Construct concrete bases 4 inches high and extend base not less than 6 inches in all directions beyond the maximum dimensions of boiler unless otherwise indicated or unless required for seismic anchor support.
 - 4. Minimum Compressive Strength: 5000 psi at 28 days.
 - 5. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 6. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
 - 7. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 8. Install anchor bolts to elevations required for proper attachment to supported equipment.
- B. Install gas-fired boilers according to NFPA 54.
- C. Assemble and install boiler trim.
- D. Install electrical devices furnished with boiler but not specified to be factory mounted.
- E. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to boiler to allow service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Section 23 21 13 "Hydronic Piping."
- E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- F. Connect hot-water piping to supply- and return-boiler tapplings with shutoff valve and union or flange at each connection.
- G. Install piping from safety relief valves to nearest floor drain.
- H. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- I. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Perform installation and startup checks according to manufacturer's written instructions.
 - 2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Remove and replace malfunctioning units and retest as specified above.

- D. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Video training sessions. Refer to Section 01 79 00 "Demonstration and Training."

END OF SECTION 23 52 16

SECTION 237416

PACKAGED ROOFTOP UNITS - ERU

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes the design, controls and installation requirements for packaged rooftop units / outdoor air handling units.

1.3 COMMISSIONING

- A. Division 23 will be responsible to carry out the commissioning requirements specified in Section 230010, and 230800.

1.4 SUBMITTALS

- A. Submit shop drawings for all materials specified in this section in accordance with Section 23 0050:
 - 1. Include rated capacities, operating characteristics, fan performance curves, filter information, electrical characteristics, and furnished specialties and accessories. Include plans, sections, and mounting or attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field installation, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
 - 4. Operation and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.
- B. Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.
- C. Unit Energy Efficiency Ratio (EER) shall be equal to or greater that prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.
- D. Unit shall be safety certified by ETL and ETL US listed. Unit nameplate shall include the ETL/ETL Canada label.

1.6 WARRANTY

- A. Provide 5-year extended manufacturer warranty.
- B. The warranty period shall start at the date of overall substantial completion for the project.
- C. Mechanical equipment shall not be used during construction. Contractor shall provide temporary heat/cooling/dehumidification as required, without using the Owner's permanent HVAC equipment.
- D. Submit a sample warranty for approval before purchasing equipment.
- E. See section 01 77 00 – Closeout Procedures for additional warranty requirements.

PART 2 - PRODUCTS

2.1 PACKAGED ROOFTOP UNITS

- A. Packaged rooftop unit shall include compressors, evaporator coils, filters, supply fans, dampers, air-cooled condenser coils, condenser fans, reheat coil, electric heaters, exhaust fans, and unit controls. Units shall be as manufactured by Trane, Carrier, (JCI) York, Daikin or approved equal.
- B. Unit shall be factory assembled and tested including leak testing of the DX coils, pressure testing of the refrigeration circuit, and run testing of the completed unit. Run test report shall be supplied with the unit in the service compartment's literature pocket.
 - 1. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
 - 2. Unit components shall be labeled, including refrigeration system components and electrical and controls components.
 - 3. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's hinged access door.
- C. Construction
 - 1. All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.
 - 2. Unit insulation shall have a minimum thermal resistance R-value of 13. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D1929-11 for a minimum flash ignition temperature of 610°F.
 - 3. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, prevents heat transfer through the panel, and prevents exterior condensation on the panel.
 - 4. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 340/360. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a

NOT FOR BID

maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width. Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.

5. Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.
6. Access to filters, dampers, cooling coils, reheat coil, heaters, exhaust fans, compressors, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.
7. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
8. Units with cooling coils shall include double sloped 304 stainless steel drain pans.
9. Unit shall be provided with base discharge and return air openings. All openings through the base pan of the unit shall have upturned flanges of at least 1/2 inch in height around the opening.
10. Unit shall include lifting lugs on the top of the unit.
11. Unit base pan shall be provided with 1/2 inch thick foam insulation.

D. Electrical

1. Unit shall be provided with factory installed and factory wired, non-fused disconnect switch.
2. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a power terminal block for main power connection. A terminal board shall be provided for low voltage control wiring. Branch circuit short circuit protection, 115 volt control circuit transformer and fuse, system switches, and a high temperature sensor. Each compressor and condenser fan motor shall be furnished with contactors and inherent thermal overload protection. Supply and return fan motors shall have contactors and external overload protection. Knockouts shall be provided in the of the main control panels for field wiring entrance.
3. Unit shall be provided with a factory installed and factory wired 115V, 13 amp GFI outlet disconnect switch in the unit control panel.
4. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more than 10% out of balance on voltage, the voltage is more than 10% under design voltage or on phase reversal.

E. Supply Fans

1. Unit shall include direct drive, unhooded, backward curved, plenum supply fans.
2. Blowers and motors shall be dynamically balance and mounted on rubber isolators.
3. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
4. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency.

F. Exhaust Fans

1. Exhaust dampers shall be sized for 100% relief.
2. Fans and motors shall be dynamically balanced.
3. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
4. Access to exhaust fans shall be through double wall, hinged access doors with quarter turn lockable handles.
5. Unit shall include belt driven, forward curved exhaust fans.

G. Cooling Coils

1. Evaporator Coils
 - a. Coils shall be designed for use with R-410A refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.
 - b. Coils shall have interlaced circuitry and shall be standard capacity.
 - c. Coils shall be hydrogen or helium leak tested.
 - d. Coils shall be furnished with factory installed expansion valves.

H. Refrigeration System

1. Unit shall be factory charged with R-410A refrigerant.
2. Compressors shall be scroll type with thermal overload protection and carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory.
3. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged compressor access doors shall be fabricated of double wall, rigid polyurethane foam injected panels to prevent the transmission of noise outside the cabinet.
4. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
5. Each refrigeration circuit shall be equipped with expansion valve type refrigerant flow control.
6. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides and a factory installed replaceable core liquid line filter driers.
7. Unit shall include a variable capacity scroll compressor on all refrigeration circuits which shall be capable of modulation from 10-100% of its capacity.
8. Lead refrigeration circuit shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.
9. Unit shall be configured as an air-source heat pump. Each refrigeration circuit shall be equipped with a factory installed liquid line filter drier with check valve, reversing valve, accumulator, and expansion valves on both the indoor and

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outdoor coils. Reversing valve shall energize during the heat pump cooling mode of operation.

10. Each refrigeration circuit shall include adjustable compressor lockouts.

I. Condensers

1. Condenser fans shall be a vertical discharge, axial flow, direct drive fans.
2. Heat pump outdoor coil shall be constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.
3. Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.
4. Coils shall be hydrogen or helium leak tested.
5. Condenser fans shall be VFD driven variable speed for condenser head pressure control. Factory provided and factory programmed VFDs shall continuously modulate the fan air flow to maintain head pressure at acceptable levels. Cooling operation shall be allowed down to **35°F** with adjustable compressor lockouts.

J. Hot Water Heating Coils

1. Hot water reheat coils shall be provided where scheduled. Coils shall be constructed of aluminum fins mechanically bonded to copper tubes. Coils shall be designed for minimum working pressure of 150 psig and shall be air tested under water at minimum 250 psig. Coil capacity shall be as scheduled and shall be ARI certified.

K. Filters

1. Unit shall include 4 inch thick, pleated panel filters with an ASHRAE efficiency of 65% and a MERV rating of 11, upstream of the cooling coil. Unit shall also include 2 inch thick, pleated panel pre filters with an ASHRAE efficiency of 30% and MERV rating of 8, upstream of the 4 inch standard filters.

L. Enthalpy Wheel

1. Unit shall include enthalpy wheel, energy recovery for both latent and sensible heat transfer. Energy recovery control shall consist of starting / stopping an exhaust fan, modulating the speed of the exhaust fan, starting, and stopping an enthalpy wheel. The outdoor dampers are controlled in a normal manner.
2. Provide single enthalpy wheel without economizer (100% outdoor air unit).

M. Outdoor Air

1. Unit shall include 0-100% economizer consisting of a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 20 cfm of leakage per sq ft. at 4 in. w.g. air pressure differential across the damper. Low leakage dampers shall be Class 2 AMCA certified, in accordance with AMCA Standard 511. Damper assembly shall be controlled by spring return enthalpy activated fully modulating actuator. Unit shall include outside air opening bird screen, outside air hood, and barometric relief dampers.

2. Unit shall include 100% motor operated outside air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge and end seals. Damper blades shall be gear driven and designed to have no more than 20 cfm of leakage per sq ft. at 4 in. w.g. air pressure differential across the damper. Low leakage dampers shall be Class 2 AMCA certified, in accordance with AMCA Standard 511. Damper assembly shall be controlled by spring return, 2 position actuator. Unit shall include outside air opening bird screen and outside air hood.

N. Controls

1. Factory Installed and Factory Provided Controller
 - a. Unit controller shall be capable of controlling all features and options of the unit. Controller shall be factory installed in the unit controls compartment and factory tested. Controller shall be capable of stand alone operation with unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling available without dependence on a building management system.
 - b. Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.
 - c. Controller shall include non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.
 - d. Constant Volume Controller
 - 1) Unit shall modulate cooling with constant airflow to meet space temperature cooling loads.
 - 2) With modulating hot gas reheat, unit shall modulate cooling and hot gas reheat as efficiently as possible, to meet space humidity loads and prevent supply air temperature swings and overcooling of the space.
 - 3) Unit shall modulate heating with constant airflow to meet space temperature heating loads. Modulating heating capacity shall modulate based on supply air temperature.
 - e. Unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling shall be accomplished with connection to interface module with LCD screen and input keypad, interface module with touch screen, or with connection to PC with free configuration software. Controller shall be capable of connection with other factory installed and factory provided unit controllers with individual unit configuration, setpoint adjustment, sensor status viewing, and occupancy scheduling available from a single unit. Connection between unit controllers shall be with a modular cable. Controller shall be capable of communicating and integrating with a **BACnet** network.

O. Accessories

1. Unit shall be provided with a safety shutdown terminal block for field installation of a smoke detector which shuts off the unit's control circuit.
2. Provide manufacturers standard roof curb.

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PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install unit, including field installed components, in accordance with manufacturers Installation, Operation, and Maintenance manual instructions.

3.2 STARTUP SERVICE

- A. Start up and maintenance requirements shall be complied with to ensure safe and correct operation of the unit.
- B. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.3 ADJUSTING

- A. Adjust moving parts to function smoothly, and lubricate as recommended by manufacturer.

3.4 DEMONSTRATION

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

END OF SECTION 237416

SECTION 23 74 16
PACKAGED ROOFTOP 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 the design, controls and installation requirements for packaged rooftop units / outdoor air handling units.

1.3 SUBMITTALS

- A. Submit shop drawings for all materials specified in this section.
 - 1. Include rated capacities, operating characteristics, fan performance curves, filter information, electrical characteristics, and furnished specialties and accessories. Include plans, sections, and mounting or attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field installation, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
 - 4. Operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.
- B. Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.
- C. Unit Energy Efficiency Ratio (EER) shall be equal to or greater that prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.
- D. Unit shall be safety certified by ETL and ETL US listed. Unit nameplate shall include the ETL/ETL Canada label.

1.5 WARRANTY

- A. Provide 5-year extended manufacturer warranty.
- B. The warranty period shall start at the date of overall substantial completion for the project.

- C. Mechanical equipment shall not be used during construction. Contractor shall provide temporary heat/cooling/dehumidification as required, without using the Owner's permanent HVAC equipment.
- D. Submit a sample warranty for approval before purchasing equipment.
- E. See section 01 77 00 – Closeout Procedures for additional warranty requirements.

PART 2 - PRODUCTS

2.1 PACKAGED ROOFTOP UNITS

- A. Packaged rooftop unit shall include compressors, evaporator coils, filters, supply fans, dampers, air-cooled condenser coils, condenser fans, reheat coil, electric heaters, exhaust fans, and unit controls. Units shall be as manufactured by Trane, Carrier, (JCI) York, Daikin or approved equal.
- B. Unit shall be factory assembled and tested including leak testing of the DX coils, pressure testing of the refrigeration circuit, and run testing of the completed unit. Run test report shall be supplied with the unit in the service compartment's literature pocket.
 - 1. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
 - 2. Unit components shall be labeled, including refrigeration system components and electrical and controls components.
 - 3. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's hinged access door.
- C. Construction
 - 1. All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.
 - 2. Unit insulation shall have a minimum thermal resistance R-value of **13**. Foam insulation shall have a minimum density of 1-1/2 pounds/cubic foot and shall be tested in accordance with ASTM D1929-11 for a minimum flash ignition temperature of 610°F.
 - 3. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, prevents heat transfer through the panel, and prevents exterior condensation on the panel.
 - 4. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 340/360. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width. Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.
 - 5. Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.
 - 6. Access to filters, dampers, cooling coils, reheat coil, heaters, exhaust fans, compressors, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.

7. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
8. Units with cooling coils shall include double sloped 304 stainless steel drain pans.
9. Unit shall be provided with side discharge and **and** return air openings. All openings of the unit shall have upturned flanges of at least 1/2 inch in height around the opening.
10. Unit shall include lifting lugs on the top of the unit.
11. Unit base pan shall be provided with 1/2 inch thick foam insulation.

D. Electrical

1. Unit shall be provided with factory installed and factory wired, non-fused disconnect switch. AHU-1 to be provided with dual power connections and AHU-2 to be provided with single point power connections.
2. Unit shall be provided with a factory installed and fielded wired 115VGFI outlet disconnect switch in the unit control panel.
3. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more than 10% out of balance on voltage, the voltage is more than 10% under design voltage or on phase reversal.

E. Supply Fans

1. Unit shall include direct drive, unhooded, backward curved, plenum supply fans.
2. Blowers and motors shall be dynamically balance and mounted on rubber isolators.
3. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
4. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency.

F. Return Fans

1. Relief dampers shall be sized for 100% relief.
2. Fans and motors shall be dynamically balanced.
3. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
4. Access to exhaust fans shall be through double wall, hinged access doors with quarter turn lockable handles.
5. Unit shall include belt driven, forward curved exhaust fans.

G. OUTDOOR AIRFLOW MEASUREMENT SYSTEMS

1. Provide airflow measurement system for monitoring and controlling minimum outdoor airflow rate.
2. Basis-of-Design Product: Subject to compliance with requirements, provide Paragon Controls Inc., Model OAFE-1550 or equal as approved by the Engineer.
3. Measure minimum amount of outside air as recommended by ASHRAE 62.1-2010, Ventilation for Acceptable Indoor Air Quality, and provide input to building automation system linear to measured airflow rate.
4. Tested in accordance with AMCA 610, Figure 4, Methods of Testing Airflow Measurement Stations for Rating, and AMCA 611, Certified Ratings Program – Airflow Measurement Performance, in an AMCA-registered testing facility and bear the AMCA International Certified Ratings Seal for Airflow-Measurement Station Performance.
5. Accurate to plus or minus 0.5 percent over operating range of 200 to 1,200 fpm (1 to 6 m per second), and within plus or minus 5 percent for operating ranges as low as 100 fpm (0.5 m per second).

H. Cooling Coils

1. Evaporator Coils

- a. Coils shall be designed for use with **R-32** refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.
- b. Coils shall have interlaced circuitry and shall be standard capacity.
- c. Coils shall be hydrogen or helium leak tested.
- d. Coils shall be furnished with factory installed expansion valves.

I. Refrigeration System

1. Unit shall be factory charged with **R-32** refrigerant.
2. Compressors shall be scroll type with thermal overload protection and carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory.
3. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged compressor access doors shall be fabricated of double wall, rigid polyurethane foam injected panels to prevent the transmission of noise outside the cabinet.
4. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
5. Each refrigeration circuit shall be equipped with expansion valve type refrigerant flow control.
6. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides and a factory installed replaceable core liquid line filter driers.
7. Unit shall include a variable capacity scroll compressor on all refrigeration circuits which shall be capable of modulation from 10-100% of its capacity.
8. Lead refrigeration circuit shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.
9. Unit shall be configured as an air-source heat pump. Each refrigeration circuit shall be equipped with a factory installed liquid line filter drier with check valve, reversing valve, accumulator, and expansion valves on both the indoor and outdoor coils. Reversing valve shall energize during the heat pump cooling mode of operation.
10. Each refrigeration circuit shall include adjustable compressor lockouts.

J. Condensers

1. Condenser fans shall be a vertical discharge, axial flow, direct drive fans.
2. Heat pump outdoor coil shall be constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.
3. Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.
4. Coils shall be hydrogen or helium leak tested.
5. Condenser fans shall be VFD driven variable speed for condenser head pressure control. Factory provided and factory programmed VFDs shall continuously modulate the fan air flow to maintain head pressure at acceptable levels. Cooling operation shall be allowed down to **35°F** with adjustable compressor lockouts.

K. Hot Water Heating Coils

1. Hot water reheat coils shall be provided where scheduled. Coils shall be constructed of aluminum fins mechanically bonded to copper tubes. Coils shall be designed for minimum working pressure of 150 psig and shall be air tested under water at minimum 250 psig. Coil capacity shall be as scheduled and shall be ARI certified.

L. Filters

1. Unit shall include 2 inch thick, pleated panel filters with an ASHRAE efficiency of 95% and a MERV rating of 13, upstream of the cooling coil.
- M. Outdoor Air
1. Unit shall include 0-100% economizer consisting of a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 20 cfm of leakage per sq ft. at 4 in. w.g. air pressure differential across the damper. Low leakage dampers shall be Class 2 AMCA certified, in accordance with AMCA Standard 511. Damper assembly shall be controlled by spring return enthalpy activated fully modulating actuator. Unit shall include outside air opening bird screen, outside air hood, and barometric relief dampers.
- N. Weather hood shall be of the same finish as the unit. Hood to be factory installed. Outdoor air openings shall be a minimum of 2' above the roof to prevent intake of duct and debris.
- O. Controls
1. Factory Installed and Factory Provided Controller
 - a. Unit controller shall be capable of controlling all features and options of the unit. Controller shall be factory installed in the unit controls compartment and factory tested. Controller shall be capable of stand alone operation with unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling available without dependence on a building management system.
 - b. Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.
 - c. Controller shall include non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.
 - d. Unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling shall be accomplished with connection to interface module with LCD screen and input keypad, interface module with touch screen, or with connection to PC with free configuration software. Controller shall be capable of connection with other factory installed and factory provided unit controllers with individual unit configuration, setpoint adjustment, sensor status viewing, and occupancy scheduling available from a single unit. Connection between unit controllers shall be with a modular cable. Controller shall be capable of communicating and integrating with a **BACnet** network.
 - e. Variable Volume Controller (Provided by BAS Contractor)
 - 1) Supply air fan to be controlled by duct static pressure. Return fan to be controlled via fan tracking.
 - 2) With modulating hot gas reheat, unit shall modulate cooling and hot gas reheat as efficiently as possible, to meet space humidity loads and prevent supply air temperature swings and overcooling of the space.
 - 3) A comparative enthalpy controls shall be provided to sense and compare enthalpy in both the outdoor and return air streams to determine if outdoor air is suitable for economizer operation.
- P. Accessories
1. AHU-1 & 2 shall be field provided with a smoke detector sensing the **return and supply** air of the unit, wired to shut off the unit's control circuit.
 2. Unit shall be provided with a safety shutdown terminal block for field installation of a smoke detector which shuts off the unit's control circuit.
 3. Provide manufacturers standard tapered roof curb at 1/4" per foot slope with spring isolation mounts.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install unit, including field installed components, in accordance with manufacturers Installation, Operation, and Maintenance manual instructions.

3.2 STARTUP SERVICE

- A. Start up and maintenance requirements shall be complied with to ensure safe and correct operation of the unit.
- B. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.3 ADJUSTING

- A. Adjust moving parts to function smoothly, and lubricate as recommended by manufacturer.

3.4 DEMONSTRATION

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

END OF SECTION 237416

SECTION 23 81 00

PACKAGED AND SPLIT-SYSTEM AIR-CONDITIONING 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 split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 COMMISSIONING

- A. Division 23 will be responsible to carry out the commissioning requirements specified in Section 23 00 10 Mechanical General Provisions, and 23 08 00 Commissioning of HVAC Systems.

1.4 SUBMITTALS

- A. Submit shop drawings for all materials specified in this section in accordance with Section 23 00 50:
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Include mounting or attachment details, and finishes.
 - 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. Operation and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

PART 2 - PRODUCTS

2.1 SPLIT-SYSTEM A/C UNIT (Ductless or Ducted)

- A. The system shall consist of a slim, silhouette, compact wall mounted evaporator unit with wireless controller and a horizontal discharge, single phase outdoor unit. The system shall be Daikin FTX or equal. Unit performance shall be based on 80°F DB, 67°F WB for the indoor unit and 95°F DB, 75°F WB for the outdoor unit.
- B. Where Scheduled, ducted units shall be Daikin Model FBQ or approved equal.
- C. The unit shall be listed by Electrical Laboratories (ETL) and shall bear ETL label. All wiring shall be in accordance with the National Electric Code (NEC). The units shall be rate on accordance with ARI Standard 210.
- D. The unit shall be ENERGY STAR certified.
- E. The indoor unit shall be factory assembled, wired and run tested. The unit cabinet shall contain all factory wiring, piping, control circuit board and fan motor. The unit cabinet shall have a white finish with a separate back plate that secures the unit to the wall.
- F. The evaporator fan shall be an assembly with a direct drive fan with a single motor. The fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings.
- G. The unit shall be provided with a removable, washable filter.
- H. The evaporator coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tubing joints shall be brazed with phoscopper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil.
- I. The outdoor unit shall be designed specifically for use with the indoor unit. The unit shall be factory assembled, piped and wired. The casing shall be fabricated of galvanized steel, bonderized and finished with a powder coated baked enamel. The unit shall be provided with a direct drive, propeller type fan driven by a motor with permanently lubricated bearings. The condenser coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing. Refrigerant flow from the condenser shall be controlled by means of a meter orifice. The compressor shall be a high performance rotary equipped with an internal thermal overload. The unit electrical power shall be as indicated on the contract drawings.
- J. For units serving accessible spaces (e.g. electrical rooms, IT rooms, etc.), provide wired wall-mounted controller.
- K. For units serving elevator shafts, provide factory installed return inlet temperature transmitter to be used for unit control. Setpoint adjustment to be from the BAS via BACnet connection

- L. Provide BACnet interface for connection to the building automation system.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install all equipment in accordance with manufacturer's printed instructions and as indicated. Provide all required utilities, wiring, and accessories indicated or required. Properly test each piece of equipment to assure proper operation and demonstrate same to Owner's designated representative. Remove and replace at no expense to the Owner any item of equipment deemed by the Architect to be unsatisfactory.
- B. Provide startup and adjustments for all systems and equipment in accordance with the manufacturer's recommendations using personnel who are factory trained and certified by factory as factory authorized personnel.

3.2 STARTUP COMMISSIONING

- A. Verify that shipping, blocking, and bracing are removed.
- B. Verify that equipment is secure on mountings and supporting devices and that connections to piping, ductwork, and electrical systems are complete.
- C. Verify proper rotation and proper thermal-overload.
- D. Provide lubrication of all components with factory-recommended lubricants.
- E. Verify operating safeties are in place, piped or discharging to a safe location and functional prior to startup including but limited to the following:
 - 1. Electrical – Overloads installed, disconnects accessible, equipment covers and guards installed.
 - 2. Provide documentation of all pressure testing (piping, ductwork, and pressure vessels).
 - 3. Retouch any marred or scratched factory-finished surfaces with materials furnished by the manufacturer.

3.3 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the equipment.
- B. Record videos on DVD disks.
- C. Owner shall have right to make additional copies of video for internal use without paying royalties.

END OF SECTION 23 81 00

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SECTION 23 82 00

HEATING AND AIR CONDITIONING TERMINAL EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:
 - 1. Unit Heaters
 - 2. Cabinet Unit Heaters
 - 3. Finned-tube Radiation
 - 4. Cast Iron Radiators
 - 5. Blower Coil Units
 - 6. Air Curtains

1.3 COMMISSIONING

- A. Division 23 will be responsible to carry out the commissioning requirements specified in Section 23 00 10, and 230800.

1.4 SUBMITTALS

- A. Submit shop drawings for all materials specified in this section in accordance with section 23 00 50.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the product.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Include plans, elevations, sections, and mounting or attachment details.
 - 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 4. Include diagrams for power, signal, and control wiring.
 - 5. Operation and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 UNIT HEATERS

- A. Unit heaters shall be as manufactured by Daikin, Sterling, Airtherm, Engineered Air, or approved equal. Casing shall be 18 gauge steel finished with a baked enamel paint. Back panel shall be removable to provide coil access.
- B. Fan shall be of the propeller design with aluminum blades. Fan motor shall be totally enclosed; permanently lubricated variable speed with built-in overload protection.
- C. Hot water coil shall be copper tube of the single tube serpentine design with flat aluminum blades mechanically bonded to copper tubes. Coil shall be leak tested at 300 psig.
- D. Electric-Resistance Heating Coil shall be nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch. Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F at any point during normal operation. Provide Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters.
- E. Coil shall be tested and rate in accordance with ASHRAE 33.
- F. Units designed for horizontal applications shall be equipped with adjustable discharge louvers. Vertical units shall be equipped with conical diffuser.

2.2 CABINET UNIT HEATERS

- A. Cabinet heaters shall be as manufactured by Daikin, Carrier, Markel, Airtherm, Sterling or approved equal, in compliance with AHRI 440.
- B. Cabinets shall be constructed of minimum 16 gauge front panels and minimum, 18 gauge end and top panels. Integral stamped, inlet and outlet grilles shall have 15° downward deflection. Front panel shall be insulated over the entire coil section. Hinged access door and front panel shall have cam locked fasteners. Cabinet parts shall be cleaned, bonderized, phosphatized and painted with baked enamel. Color as selected by Architect.
- C. Hot water coils shall be 1/2-inch O.D. copper tubes with flat aluminum fins mechanically bonded. Coils shall be leak tested at 300 psig. Supply and return pipe connections shall be at the same end.
- D. Provide cabinet unit heaters of the configurations indicated on the drawings.
- E. Filters shall be 1" replaceable fiberglass with a MERV 5 rating in accordance with ASHRAE 52.2.
- F. Fans shall be forward-curved, double width centrifugal type with permanent split capacitor motors equipped with built-in overload protection. Vent shall be equipped with unit mounted three-speed fan switch, and detachable motor cords. All wiring shall be in accordance with the National Electrical Code and shall be U.L. listed.

2.3 FINNED TUBE RADIATION

- A. Furnish and install fin tube radiation with capacity and continuous wall-to-wall enclosure lengths as indicated on the drawings. Contractor shall furnish detailed shop drawings for approval by the engineer and architect.
- B. Finned tube radiation shall be Vulcan or equal to the following types:
 - Type I - Vulcan Dura-Vane JDVP41-VC435-10LI
- C. Type I: Provide custom wall mounted enclosure. Enclosure shall include top outlet grille and front louvered inlet tight to floor. Enclosure shall be maximum of 4-1/2" wide. Coordinate with mechanical schedules and architectural drawings for height.
- D. Enclosures shall be minimum 16 gauge steel and factory finished in baked enamel in color as selected by Architect. Custom enclosures shall include horizontal louver at base and shall be installed flush to wall.
- E. Heating elements shall be copper fin with flat aluminum fins mechanically bonded. Elements shall be rated at the BTU/HR per linear foot indicated on the drawings. Elements shall be supported by a pedestal mounted bracket and saddle assembly.
- F. Where multiple sections are joined, provide flexible pipe connectors and trim cover kits. Provide and trim kits for each end of radiation. No unfinished metal edges shall be visible when the product is installed.
- G. Provide all accessories required for the complete installation.
- H. Provide access doors at valves and vents, and dial operated dampers.

2.4 CAST IRON RADIATORS

- A. Furnish and install cast iron radiators with capacity and in custom configuration as indicated on the drawings. Contractor shall furnish detailed shop drawings for approval. Radiators shall be factory painted custom color, to be submitted to architect for approval.
- B. Radiators shall be constructed of durable cast iron. Tube sections shall include ornate surface detail. Tube sections shall be suitable for 180°F heating supply and return water.
- C. Provide ornate brass valves from radiator manufacturer suitable for functional balancing and shutoff.
- D. Provide all accessories required for the complete installation.
- E. Cast iron radiators shall be as manufactured by Burnham, Hudson Reed, Cast Rads, or approved equal.

2.5 BLOWER COIL UNITS

- A. Fan coil units shall be as manufactured by Daikin, Carrier, Johnson Controls (York), or equal.
- B. Cabinets shall be constructed of minimum 18 gauge channel-formed panel. All cabinet parts shall be cleaned, bonderized, phosphatized, and finished with baked enamel. Color as selected by Architect. Discharge grilles shall be adjustable diffuser type.
- C. Coils shall be 1/2-inch O.D. copper tubes with flat aluminum fins mechanically bonded. Coils shall be leak tested at 300 psig. Coil sections shall be provided with insulated drain pans.
- D. Filters shall be 1" replaceable fiberglass with a MERV 7 rating in accordance with ASHRAE 52.2.
- E. Fans shall be forward-curved, double width centrifugal type with permanent split capacitor motors equipped with built-in overload protection. Units shall be equipped with unit mounted three-speed fan switch and detachable motor cords. All wiring shall be in accordance with the National Electrical Code and shall be U.L. listed. Motors shall be provided with extended lube lines.
- F. Unit arrangements and capacities shall be as scheduled.

2.6 AIR CURTAINS

- A. Air Curtains shall be Berner Series Architectural Recessed 12 (ARC12), Mars Air Door, or approved equal.
- B. Provide factory-assembled units of sufficient structural strength to be supported from ends without intermediate support. Ship units completely assembled
- C. Cabinet:
 - 1. Material and Finish: Minimum 16-gage aluminized steel cabinet with welded construction powder coated aluminum bottom cover and screen. Provide custom color to be selected by the architect.
 - 2. Dimensions: Not to exceed 15.25 in high by 26.25 in deep.
 - 3. Mounting: Provide for suspended mounting.
 - 4. Service Access: Hinged removable screen and removable bottom access panel.
- D. Provide two-year factory warranty.
- E. Motors: 1/2-HP, 1680 RPM, single phase, 3-speed, ODP, direct drive, resilient mounted, continuous duty, with internal thermal-overload protection and permanently lubricated sealed ball bearings.
- F. Fans: Balanced forward curved type, double inlet, mounted in matched fan housings with aerodynamically formed air inlet venturis. Manufacture wheels and housings from galvanized steel.
- G. Discharge Nozzles:
 - 1. Provide uniform velocity across width of air curtain.
 - 2. Aperture: 3.5 in (9 cm) slot by width of air curtain.

- H. Vanes: 1.5 in (3.8 cm) minimum height; constructed of airfoil-shaped aluminum extrusions; adjustable plus or minus 20 degrees to deflect airflow.
- I. Inlet:
 - 1. Location: Bottom.
 - 2. Screen: Perforated custom color powder coated aluminum with aluminum bottom cover.
- J. Air inlet filter: Flat faced fire rated re-cleanable polyester with integral filter bracket.
- K. Hot Water Coil: Certified in accordance with ARI 410; 16-gage galvanized steel casing, 5/8-inch (15.8 mm) outside diameter copper tube with aluminum fins and seamless copper headers.
 - 1. Characteristics: Design to operate at maximum 250-psig (1720-kPa) and 300 degrees F (149 degrees C) hot water.
 - 2. Leak-test under water at 350-psig (2415-kPa) dry nitrogen.
 - 3. Factory mount coil on air intake and protect with perforated metal screen.
- L. Unit shall be provided with a UL Listed, factory mounted and wired digital programmable controller (equal to Berner Intelliswitch) with the following features:
 - 1. 5 volt DC output for control circuit.
 - 2. Lock and Unlock tamperproof feature.
 - 3. Motor and switching suitable for 10 fan speed settings.
 - 4. Programmable fan start and fan stop time with provisions to set the start and stop times for any of the week.
 - 5. Programmable settings for all user controlled options.
 - 6. Adjustable time delay from 0 to 10 minutes.
 - 7. Five (5) preset and three (3) customizable programs - On, Off, Automatic, Deluxe, Comfort Plus, Program 1, Program 2, and Program 3.
 - 8. Fan fail lockout.
 - 9. Built-in capillary style thermostat for heated units with temperature settings of 34 degrees F to 90 degrees F (one (1) degree C to 32 degrees C).
 - 10. Two (2) heating modes, one (1) call for heat and one (1) call for fan and heat.
 - 11. Emergency stop.
 - 12. Clock with lighted display.
 - 13. Provide BACNET interface for connection to the building automation system.
- M. Unit mounted display.
- N. Provide door switch compatible with sliding entry doors.
- O. Provide remote wall-mounted thermostat.
- P. Disconnect Switch: Provide lockable factory mounted non-fused toggle disconnect switch for remote mounting in the field.
- Q. Installing contractor shall adjust discharge nozzles in accordance with the manufacturer's recommendations to deflect air outward.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install all equipment in accordance with manufacturer's printed instructions and as indicated. Provide all required utilities, wiring, and accessories indicated or required. Properly test each piece of equipment to assure proper operation and demonstrate same to Owner's designated representative. Remove and replace at no expense to the Owner any item of equipment deemed by the Architect to be unsatisfactory.
- B. Provide start-up and adjustments for all systems and equipment in accordance with the manufacturer's recommendations using personnel who are factory trained and certified by factory as factory authorized personnel.

3.2 UNIT HEATER INSTALLATION

- A. Install unit heater to comply with NFPA 90A
- B. Install unit heaters level and plumb. Install piping to allow service and maintenance.
- C. Suspend unit heaters from structure with all-thread hanger rods and vibration isolators.
- D. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls.

3.3 FINNED TUBE RADIATION INSTALLATION

- A. Install units level and plumb.
- B. Install enclosure continuously around corners, using outside and inside corner fittings.
- C. Join sections with splice plates and filler pieces to provide continuous enclosure.
- D. Install access doors for access to valves
- E. Install enclosure continuously from wall to wall.
- F. Terminate enclosures with manufacturer's end caps except where enclosures are indicated to extend to adjoining walls.
- G. Install valve within reach of access door provided in enclosure.
- H. Install air-seal gasket between wall and recessed flanges or front cover of fully recessed unit.
- I. Install piping within pedestals for freestanding units.

3.4 CAST IRON RADIATOR INSTALLATION

- A. Install units level and plumb.

- B. Join sections in accordance with manufacturer recommendations. All threaded nipples to be tightened to manufacturer's torque specifications.
- C. Install piping and valves on lower of the two treaded connections.
- D. Terminate open threaded connections with manufacturer's end caps.

3.5 START-UP COMMISSIONING

- A. Verify that shipping, blocking, and bracing are removed.
- B. Verify that equipment is secure on mountings and supporting devices and that connections to piping, ductwork, and electrical systems are complete.
- C. Verify proper rotation and proper thermal-overload.
- D. Provide lubrication of all components with factory-recommended lubricants.
- E. Verify operating safeties are in place, piped or discharging to a safe location and functional prior to startup including but limited to the following:
 - 1. Heating system – pressure vessel relief's, high temperature shutdowns.
 - 2. Electrical – Overloads installed, disconnects accessible, equipment covers and guards installed.
 - 3. Provide documentation of all pressure testing (piping, ductwork, and pressure vessels).
 - 4. Protect all equipment/systems operating during temporary or start-up operation. Provide startup filtration (water/air), strainers (water) to protect equipment.
 - 5. Retouch any marred or scratched factory-finished surfaces with materials furnished by the manufacturer.

END OF SECTION 23 82 00

SECTION 26 00 10

ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SCOPE

- A. This section describes the general provisions for the electrical work included in Division 26. This section applies to all sections of Division 26.

1.3 RESPONSIBILITY

- A. The General Contractor shall be responsible for all work included in the Electrical Division and the delegation of work to Subcontractors shall not relieve him of this responsibility. Subcontractors who perform work under these Sections shall be responsible to the General Contractor. The term "Contractor" is used throughout this Division and shall mean the General Contractor, although the actual performance of the work may be by a Subcontractor.

1.4 REFERENCE AND DEFINITIONS

- A. Following are definitions of terms and expressions used in the Electrical Sections. In addition to those used in Division 01 Sections.
 - 1. Owner: State of Delaware, OMB/DFM
 - 2. Architects: Tevebaugh Architecture
 - 3. Engineers: WSP USA Buildings Inc.
 - 4. Provide - "Furnish and install"
 - 5. Concealed - "hidden from normal sight"; includes items in shafts, pipe and duct spaces, and above ceilings.
 - 6. Exposed - "not concealed" - Work within Equipment Rooms and all visible (normal sight) work shall be considered exposed.
 - 7. Directed- "directed by the Engineer"
 - 8. Indicated- "indicated in Contract Documents"

1.5 STANDARD SPECIFICATIONS

- A. See General Requirements of the contract.
- B. References to catalogs, standards, codes, specifications, and regulations are the latest edition in effect at date of invitation to bid.

1.6 CODES, REGULATIONS AND PERMITS

- A. Give all necessary notices and obtain all required permits. Pay all fees and other costs, including utility connections or extensions in connection with the work. File all necessary plans, prepare all documents and obtain all necessary approvals of all governmental departments having jurisdiction. Obtain all required certificates of inspection and deliver same to the Engineer before request for acceptance and final payment for the work.
- B. The electrical installation shall be inspected and approved by the inspection department of the governmental agency having jurisdiction, and certificates documenting approval shall be furnished to the Architect before requests for final payment. The Contractor shall allow inspections at any time and shall not impede or interfere with inspections.

1.7 MATERIAL LIST AND SHOP DRAWINGS

- A. See General Requirements.
- B. Within 15 working days after the award of the Contract, the Contractor shall submit to the Architect for approval a list submittal to be included in the submittal schedule in accordance with Section 013300 Submittal Procedures. The list shall include the manufacturers of material and equipment proposed to be provided. In the event any items of material or equipment contained in the list fail to comply with the specification requirements, such items will be rejected. Rejected items shall be resubmitted within 15 days. Substitutions requests shall be submitted in accordance with specified procedure.
- C. After receiving approval of equipment manufacturers and prior to delivery of any material to job site and sufficiently in advance of requirements to allow the Engineer ample time for checking, submit for approval, dimensioned drawings or cuts showing construction size, arrangement, operating clearances, performance characteristics and capacity of materials and equipment. Each item of equipment proposed shall be a standard catalog product of the approved manufacturer.
- D. Samples, drawings, specifications, catalogs, etc., submitted for approval shall be properly labeled indicating specific service for which material or equipment is to be used, section and article number of specifications governing, and Contractor's name, name of job, and date.
- E. Catalogs, pamphlets or other documents submitted to describe items on which approval is being required shall be specific and identification in catalog, pamphlet, etc., of the item submitted shall be clearly made in ink. Data of a general nature will not be accepted. Any deviations or exceptions taken in the specification by the Contractor shall be so noted.
- F. If material or equipment is installed prior to receipt by the Contractor of approved shop drawings marked "Approved", "No Exception Taken" or "Make Corrections Noted", the Contractor shall be liable for its removal and replacement at no extra charge to the Owner.

- G. The acceptance of shop drawings shall not relieve the Contractor from his responsibility to furnish material, equipment and systems and to perform work required by the contract documents. Neither the Owner nor the Engineer will be responsible for errors or omissions on shop drawings furnished by the Contractor even though such shop drawings containing errors or omissions are inadvertently accepted.
- H. The Contractor is further advised that the Engineer will not act as coordinator between suppliers and subcontractors. All required coordination shall be the responsibility of the Contractor. Refer to other sections of these specifications for additional detailed requirements for wiring diagrams, schematic diagrams, interconnection diagrams and similar shop drawings for systems and equipment.
- I. Prepare all submittals as required for LEED certification.
- J. All re-submittals shall clearly indicate revisions by clouding or other notation to clarify which items were updated.

1.8 CONTRACTOR'S USE OF CAD/REVIT FILES

- A. At the Contractor's written request, copies of the Engineer's CAD / Revit files may be made available for Contractor use in connection with the project, subject to following conditions:
 - 1. Submit written request to the Architect listing the specific drawings the Contractor intends to use. Provide a specific list of submittals that the files will be used in preparing, and the list of names of subcontractors or suppliers.
 - 2. The Contractor shall request in writing the electronic transfer agreement. Prior to transfer of files, the Contractor shall prepare a separate electronic transfer agreement for each subcontractor or supplier who will be using the electronic files.
 - 3. Data contained on the electronic files is part of WSP USA Buildings Inc. (WSP USA), instruments of service and shall not be used for any purpose other than as a convenience in the preparation of shop drawings for the referenced project. Any other use or reuse will be at the Contractor's sole risk and without liability or legal exposure to WSP USA.
 - 4. The electronic files are not contract documents. Significant differences may exist between the electronic files and the corresponding hard copy contract documents. Because of the possibility the information and data delivered in machine readable form may be altered, whether inadvertently or otherwise, WSP USA reserves the right to retain hard copy originals of the electronic documentation delivered to the contractor, in machine readable form, which the original shall be referred to and shall govern in the event of any inconsistency between the two.
 - 5. The use of the electronic files, does not relieve the Contractor of their duty to fully comply with the contract documents, including and without limitation, the need to check confirm and coordinate all dimensions and details, take field measurements, verify field conditions and coordinate work with that of other Contractors for the project.
 - 6. All "internal" calculations integral to / performed by the Revit model shall not be utilized for any purpose by the Contractor. This includes, but shall not be limited

to, voltage drop calculations, duct static pressure calculations, air system airflow summary calculations, piping system pressure drop calculations, etc.

7. All Revit "families" are the property of WSP USA and shall not be re-used on any other project for any purpose by the Contractor.

1.9 GUARANTEE

- A. The Contractor guarantees by his acceptance of the Contract that all work provided shall be free from defects in workmanship and materials for a period of one year after date of certification of completion and acceptance of work. Any defects in workmanship, materials or performance which appear within the guarantee period shall be corrected by the Contractor without cost to the Owner within a reasonable time to be specified in notice from the Architect. In default thereof, Owner may have such work done and charge the cost of same to the Contractor.

1.10 SITE VISIT

- A. Prior to preparing the bid, the electrical subcontractors shall visit the site and familiarize themselves with all existing conditions. Make all necessary investigations as to locations of existing equipment, conduit, utilities, etc., work to be removed, and all other matters which can affect the work under the Contract. No additional compensation will be made to the contractor as result of his failure to familiarize himself with the existing conditions under which the work must be performed.

1.11 DRAWINGS

- A. The contract drawings are diagrammatic and indicate the general arrangements of systems and work included in the Contract. Do not scale the drawings. Consult the architectural and structural drawings and details for exact location of structure and equipment; where same are not definitely located, obtain this information from the Architect.
- B. The Contractor shall obtain approval of the Engineer for the final locations of all outlets, including lighting fixtures. The contractor shall make minor adjustments to the locations at no extra cost to the Owner.
- C. The Contractor shall carefully examine all contract documents and shall be responsible for the proper fitting of all materials and equipment as indicated.
- D. Although the location of materials and equipment may be shown on the drawings in a certain place, the construction may develop conditions that render this location inaccessible or impractical. In such cases, before fabricating and installing the work, the Contractor shall call the condition to the attention of the Engineer for his/her direction. When requested by the Engineer a detailed drawing of the proposed departure due to field conditions, or their causes, shall be submitted by the Contractor for approval. The Engineer shall make all final written decisions as to the conditions which require the changing of any work.
- E. Check Drawings of other trades to verify spaces in which work will be installed and field inspect existing conditions.

- F. Maintain maximum headroom at all locations.

1.12 RECORD DRAWINGS

- A. The Contractor shall keep accurate records of all deviations in work as actually installed from work indicated. One complete set of contract documents shall be available at the construction site for indicating said deviations.
- B. When work is complete, make one (1) complete "As-Built" set of PDF files, certifying the accuracy of each drawing by endorsement and signature thereon and deliver to the Architect who will, after approval, deliver the record drawings to the Owner.

1.13 OPERATION AND MAINTENANCE INSTRUCTIONS

- A. Contractor shall furnish to the Architect two (2) complete bound sets of typewritten or blueprinted instructions and one (1) PDF set for operating and maintaining all systems and equipment included in this Contract. Each set of instructions shall be contained in a hard-back ring binder properly indexed and labeled. Also provide two complete bound sets and one PDF set of approved shop drawings for all items of equipment utilized on the project. All instructions shall be submitted in draft for approval prior to the final issue. Manufacturers' advertising literature or catalogs will not be acceptable for operating and maintenance instructions.
- B. Instructions shall include a general description of each system together with specific instructions describing routine and emergency procedures required of the building maintenance personnel for operating and maintaining each system. The instructions shall include the name or label, location, and function of all operating equipment and controls, and the location of the electrical service and breaker I.D. numbers. Operating modes and the procedures for indexing each mode shall be clearly described. Include lubrication charts and schedules of frequency of lubrication for all equipment designating each point of lubrication and type of lubricant to be used. A listing of names, addresses, and phone numbers of the service organizations for each item of equipment and a typewritten maintenance schedule for same shall be included.
- C. Contractor shall prepare Operations and Maintenance Data and submit in accordance with the requirements of Section 017823 Operation and Maintenance Data.
- D. Upon completion of all work and of all tests, at a minimum the Contractor shall furnish the necessary skilled labor and helpers for operating the systems and equipment for a minimum period of two (2) days of eight hours each, or as otherwise specified. Instruct the Owner's representative fully in the operating, adjustment and maintenance of all equipment furnished. Instruction shall be divided into four (4) sessions of four (4) hours each, each at a time directed by the Owner. Refer to individual specification sections for additional training requirements.
- E. The instructors shall be thoroughly familiar with all parts of the installation on which he is to give instruction and shall be trained in operating theory as well as practical operation and maintenance work. Employ factory trained instructors wherever necessary as determined by the Engineer.

- F. During the guarantee period, the Contractor shall adjust, calibrate, and service all equipment provided under this contract, including major equipment, such as emergency generators, which require outside service agencies.
- G. Prior to the start of guarantee period, the Contractor shall provide the Architect with a schedule of required maintenance operations for each item of equipment. Submit schedule to the Architect for approval. Thereafter, monthly reports shall be submitted to the Owner for describing actual service provided. Forty eight (48) hours advance notice shall be given to Owner prior to work required under this Section.

1.14 EQUIPMENT STARTUP AND INITIAL OPERATION

- A. No equipment shall be operated for testing or trial use except after full compliance with the equipment manufacturers' specifications, instructions, and other applicable considerations.
- B. It is the Contractor's responsibility to place each item of equipment installed by him in operating condition, including all auxiliaries, conduit, wiring, etc., and to start up each unit and check it for performance.

1.15 FIRE PROTECTION

- A. As minimum, one five pound CO2 extinguisher shall be provided with each work crew at all times when working within the building.

1.16 SCHEDULE OF WORK

- A. Refer to project schedule. Specific phasing requirements are to be incorporated into the project schedule. Contractor shall coordinate all work included in this division.

1.17 SERVICE AGENCIES

- A. All electrical equipment suppliers shall have an established authorized service agency located within the Delaware area. Within 30 days after award of the Contract, the Contractor shall submit to the Engineer for approval a list of manufacturers' material and equipment names, including their respective service agency, proposed to be utilized. In the event any service agency in the list fails to comply with the specification requirement, such service agency will be rejected.

1.18 SINGULAR NUMBER

- A. Where any device or part of equipment is herein referred to in the singular number (such as "fixture"), such reference applies to as many such devices as are required to complete the installation, shown, implied or otherwise, as indicated on the drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All materials shall be new, the best of their respective kinds, suitable for the conditions and duties imposed on them at the building and shall be of reputable manufacturers.

The description, characteristics, and requirements of materials to be used shall be in accordance with qualifying conditions established in the sections following.

- B. All electrical materials shall carry the label indicating product approval or listing of a Nationally Recognized Testing Laboratory (NRTL) label when such material, equipment and/or system are of a type or class listed by a NRTL, and shall be suitable for the conditions and duties imposed on them at the building. Listing and labeling shall indicate compliance with all applicable United States product standards. Approved NRTL's shall be recognized by OSHA in accordance with Title 29 CFR 1910.7.
1. If a NRTL label is not available from the manufacturer, when requested or required by the local authority having jurisdiction, the equipment shall be tested by an approved electrical testing company in accordance with NEC at no additional cost to the Owner. Submit data indicating compliance with standards prior to installation. The description, characteristics, and requirements of materials to be used shall be in accordance with qualifying conditions established in the following sections.
- C. See Division 01 for General Requirements.
- D. All component parts of each item of equipment or device shall bear the manufacturers' name plate, giving name of manufacturer, description, size, type, serial or model number, electrical characteristics, etc, in order to facilitate the maintenance or replacement. The name plate of a subcontractor or distributor will not be acceptable. All equipment requiring electrical service shall be U.L. labeled, or if a U.L. label is not available from the manufacturer, the equipment shall be tested by an approved electrical testing company in accordance with NEC, and at no additional cost to the Owner. Submit data indicating compliance with standards prior to installation.
- E. In specifying materials, four general procedures are used. The four classifications are as follows:
1. GROUP 1: When the material or equipment is specified by name of other identifying information and one name brand only is used, it is considered that the use of that particular item is essential to the project, and the Contractor shall base his proposal on the uses of that item.
2. GROUP 2: When a material or equipment is specified by brand name and other identifying information and two or more brand names are named, it is considered that any one of the brands so named will be performed as desired, and the Contractor shall base his proposal on one of the named brands.
3. GROUP 3: When the material or equipment is specified with the phrase "... or equal..." after a brand name and other identifying information, it is intended that the brand name is used for the purpose of establishing a minimum acceptable standard of quality and performance and Contractor may base his bid proposal on any item which is in all respects equal to that specified and presents essentially the same appearance, size, operation and performance. The Contractor shall be responsible for coordination of the equal product.
4. GROUP 4: When material is specified as complying with the requirements of published "Standard Specification" of trade associations, American Society for Testing and Material, government specifications, etc., the Contractor shall base

his proposal on any item which can be shown to comply in all respects to the referred to "Standard Specification."

- F. All substitutions shall be submitted in accordance with Section 012500 Substitution Procedures. It is distinctly understood: (1) that the Engineer will use his own judgment in determining whether or not any materials, equipment or methods offered in substitution are equal to those specified and will fit within the space available; (2) that the decision of the Engineer on all such questions of equality is final; and (3) that all substitutions will be made at no increases in cost to the Owner.
- G. Upon receipt of written approval from the Engineer, Contractor may proceed with substitution providing the Contractor assumes full responsibility for and makes, at his expense, any change or adjustment in construction or connection with any work that may be required by the substitution of such materials, equipment or methods. In the event of any adverse decisions by the Engineer, no claim of any sort shall be made or allowed against the Owner.

PART 3 - EXECUTION

3.1 WORKMANSHIP

- A. Each subcontractor shall furnish the services of an experienced superintendent who shall be constantly in charge of the installation of the work.
- B. Install all electrical equipment in accordance with the requirements of the NEC, the National Electrical Contractor's Association (NECA) "Standard Practice of Good Workmanship in Electrical Construction" and the manufacturer's recommendations.
- C. The quality of workmanship required for each trade in the execution of its work shall be the finest and highest obtainable in that trade working with the materials specified. Workmanship shall be satisfactory to the Engineer and his decision as to acceptable quality if final.

3.2 EQUIPMENT CONNECTIONS

- A. All equipment shall be installed and connected in accordance with the best engineering practice and in accordance with manufacturer's instructions and recommendations.
- B. Equipment connections indicated on drawings shall be considered diagrammatic. The actual connections shall be made to best suit the requirements of each case and to minimize the space used.
- C. All conduit, outlets, wiring and all necessary fittings or accessories for connections to all electrical equipment shall be provided. All equipment ratings shown on the drawings are for the specified equipment. Should equipment of different ratings be furnished, all circuit components shall be adjusted accordingly, at the Contractor's expense, after approval by the Engineer. The contractor shall be responsible for confirming the proper size and location of each equipment connection before fabrication and installation of the work.
- D. The contractor shall review lugs and terminal configuration of all equipment, existing and new, for coordination with installed conductor sizes. Where equipment has lugs

that do not permit installation of the conductor size indicated on the drawings, the contractor shall provide adapters, or alternately, provide a pullbox in the entering raceway. Within the pullbox, provide reducing lugs and smaller size conductors with ampacity equal to or greater than the overcurrent protective device, in accordance with NEC 240.

- E. Aluminum conductors shall not be utilized where prohibited by local codes, or equipment manufacturer's installation instructions.
- F. The Contractor shall reach an agreement as to the limits of responsibility of the various trades when connecting to outlets provided by others, and when providing outlets to receive connections by others, so that all work and equipment will be provided with the proper services connected and ready to use.

3.3 COMMISSIONING RESPONSIBILITIES

- A. Refer to Specification 01 91 13 General Commissioning Requirements
- B. The electrical contractor, and all the sub-contractors and suppliers within Division 26, shall cooperate with the commissioning agency (CA), and other commissioning team members, to facilitate the successful completion of the commissioning process.
- C. The Electrical Contractor, and all electrical sub-contractors and suppliers, shall cooperate with the Commissioning Agency in carrying out the commissioning process. In this context, the Electrical Contractor shall:
 - 1. Each contractor and sub-contractor in this division shall include in their quotes the cost of participating in the commissioning process as specified herein.
 - 2. Provide instruction and demonstrations for the Owner's designated operating staff, in conjunction with the commissioning agency and electrical engineer, and with the participation of qualified technicians from major equipment suppliers and the controls contractor.
 - 3. Include requirements for submittal data, O&M data, and training information in each purchase order or sub-contract written.
 - 4. Ensure cooperation and participation of specialty sub-contractors as applicable.
 - 5. Ensure participation of major equipment manufacturing in appropriate start-up, testing and training activities.
 - 6. Attend commissioning meetings scheduled by the CA.
 - 7. Notify the CA a minimum of two weeks in advance of scheduled equipment and system start-ups, so that the CA may witness system verifications, and equipment and system startups.
 - 8. Provide sufficient personnel to assist the CA as required during system verification and functional performance testing.
 - 9. Prior to startup, inspect, check and confirm the correct and complete installation of all equipment and systems for which system verification checklists are included in the commissioning plan. Document the results of all inspections and checks on the checklists and sign them. If deficient or incomplete work is discovered, ensure corrective action is taken and re-check until the results are satisfactory and the system is ready for safe startup.
 - 10. Provide equipment and systems startup resources as specified and required. If during an attempted equipment or system startup, deficient or incomplete work is

- discovered that would preclude safe operation, the startup shall be aborted until corrective action has been taken. Ensure such action is taken and verified before re-scheduling a new startup. Those responsible for deficient or incomplete work will be responsible for the costs associated with rescheduling.
11. Carry out performance checks to ensure that all equipment and systems are fully functional and ready for the CA to witness formal functional performance tests (FPTs).
 12. Operate equipment and systems for FPTs in accordance with the commissioning plan and as directed by the commissioning agency. If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered, the FPTs will be stopped by the CA. Those responsible for deficient or incomplete work will be responsible for costs associated with rescheduling. Ensure that all corrections necessary for full and complete system operation as specified are completed; then with the applicable sub-contractors, carry out functional performance checks to confirm correct operation before applying to the CA to reschedule the FPTs for the system in question.
 13. Prepare preliminary schedule for electrical system orientation and inspections, O&M manual submission, training sessions, testing, equipment startup, and task completion for use by the CA. Update schedule as appropriate throughout the construction period.
 14. Attend initial O&M staff training session.
 15. Conduct electrical system orientation and inspection at the equipment placement completion stage.
 16. Update drawings to as-built condition and review with the CA.
 17. Prepare O&M manuals as specified herein.
 18. Participate in the O&M staff training sessions with vendors and contractors.
 19. Provide written notification to the general contractor or construction manager and CA that the following work has been completed in accordance with the contract documents and the equipment, systems and sub-systems are operating as required.
 - a. Electrical equipment including all Division 26 equipment.
 - b. Fire alarm systems.
 - c. Lighting control systems.
 - d. Fire stopping in the fire rated construction, including caulking, gasketing and sealing of smoke barriers.
 - e. Seismic restraints installation to specification; a certification from the seismic restraint engineer meets this requirement.
 20. Provide a complete set of as-built drawings and O&M manuals to the CA for review.
 21. Integrate installation and programming scheduling with construction and commissioning schedules.
 22. Provide thorough training to operating personnel on hardware operations and programming, and the application program for the system, in accordance with the O&M staff training program in the commissioning plan.

3.4 WATERPROOFING

- A. Under no circumstances shall waterproofing be damaged or penetrated. Should conditions arise which indicate such necessity, notify the Architect.

- B. Roof penetrations shall be acceptable to the Engineer, compatible with the roofing system, and acceptable to the roofing manufacturer or other agent of warranty for the roofing system.

3.5 CUTTING AND PATCHING

- A. Cutting and patching associated with the work in the existing structure shall be performed in a neat and workmanlike manner. Existing surfaces which are damaged by the Contractor shall be repaired or provided with new materials and methods similar to existing adjacent work, subject to approval of the Architect. Structural members shall not be cut or penetrated unless otherwise indicated on the drawings. Verify in the field with the Architect. Holes cut through concrete and/or masonry to accommodate new work shall be cut by reciprocating or rotary non-percussive methods. Existing masonry block walls shall be patched with new masonry or gypsum board attached and sealed to both block faces.
- B. Where existing conduits to be removed penetrate masonry walls or floor slabs, the contractor shall cut the conduits off flush with or below the concrete surface, and patch with non-shrink grout, smooth and level, ready for final finishing. Any patches which are discernable through finishes shall be removed and reapplied. Conduits encased in concrete slabs and walls may be abandoned in place after removal of conductors.

3.6 SURVEYS AND MEASUREMENTS

- A. Base all measurements (both horizontal and vertical) from established benchmarks. All work shall agree with these established lines and levels. Verify all measurements at site and check correctness of same as related to the work. Verify locations of existing utilities and inverts of same prior to the start of any systems shown connecting to utilities.
- B. Should the Contractor discover any discrepancy between actual measurements or conditions and those indicated which prevent following good practice or the intent of the drawings and specifications; he shall notify the Engineer and shall not proceed with his work until he has received instruction from the Engineer.

3.7 HANDLING AND STORAGE OF MATERIALS

- A. Proper and suitable tools, equipment and appliances for the safe and convenient handling and placing of all materials and equipment shall be used. During loading, unloading, and placing, care shall be taken in handling the equipment and materials so that no equipment or materials, including Owner furnished, are damaged.
- B. All mechanical and/or electrical equipment delivered to the job site shall be stored under roof or other approved covering, on pedestals above the ground. All enclosures for equipment shall be weatherproof. The Contractor shall follow all written instructions and recommendations of the manufacturer and all requirements of the Architect in protection and maintenance of equipment during storage. It shall be the Contractor's complete responsibility for the storage and care of the equipment and materials.

- C. If any materials and/or equipment are found to be in poor condition at the time of being installed, the Architect may, at his discretion, order the Contractor to furnish and install new equipment at no cost to the Owner.

3.8 COOPERATION WITH OTHER TRADES

- A. Exact location of electrical equipment, lighting fixtures, outlets, conduits, etc. shall be coordinated with all other trades so that there will be no interference between mechanical equipment, piping, ducts, and conduits. Where conflicts between the trades result, they shall be resolved by the Contractor to the Engineer's satisfaction and at no expense to the Owner.
- B. Electrical trades shall give full cooperation to other trades and shall furnish in writing, with copies to the Architect, all information necessary to permit the work of all trades to be installed satisfactorily and with the least possible interference or delay. Exact location of all electrical equipment in finished spaces shall be coordinated with shop drawings and with elevations indicated on the architectural drawings.

3.9 CLEANING AND PAINTING

- A. Thoroughly clean all exposed surfaces of equipment and material and leave in a neat, clean condition ready for painting. Restore and touch-up factory finishes which have been damaged during construction. Finished painting will be performed under another Division.

3.10 ACCESSIBILITY

- A. Locate all equipment which must be serviced, operated or maintained, in fully accessible positions. Equipment shall include, but not be limited to, switches, controllers, circuit breakers, and wiring splices. Where required and where directed, provide 14 gauge steel access panels, Milcor or equal, to suit material in which installed. Doors installed in fire rated walls or shafts shall be labeled and shall match rating of the construction. Door shall be of sufficient size to allow access to all components, except minimum size shall be 24" x 24", unless otherwise noted.
- B. Equipment deemed inaccessible by the Engineer shall be reworked by the Contractor at no expense to the Owner. All doors shall have cylinder locks operable from same key. Submit shop drawings for approval.

3.11 EQUIPMENT BASES AND SUPPORTS

- A. Under this Division provide all equipment supports, foundations, and stands required for the Electrical work.
- B. Where equipment is indicated or specified to be floor-mounted, stands shall be constructed of structural steel sections (or steel pipe and fittings braced and fastened with flanges) bolted to the floor.
- C. Where equipment is indicated or specified to be hung from ceiling or roof construction, the Contractor shall provide all necessary hanger rods of size and number required by

the equipment and all necessary supplemental structural steel sections, securely fastened to the building construction.

- D. Where equipment is indicated or specified to be wall-mounted, the Contractor shall provide all necessary brackets, constructed of structural steel shapes suitable for the application, securely anchored to the building construction.
- E. All motor-operated equipment, transformers and other vibrating equipment shall be mounted on rubber-in-shear vibration isolators suitable for the application, unless otherwise specified.
- F. Raceways/feeders serving motor-operated equipment, transformers, or other vibrating equipment shall be hung with vibration isolators, Mason Type 30N or equivalent by Vibration Eliminator or Korfund.
- G. Where equipment/devices are indicated to be mounted to fire-proofed structure, the contractor shall provide necessary extensions so that devices are not mounted recessed within fireproofing.
- H. All concrete bases, curbs, and supports shall be furnished under this Division unless otherwise indicated. Concrete pads shall be not less than (4) four inches high unless otherwise indicated on the drawings and shall be sized for the specific the equipment base. Exposed edges and corners shall be chamfered and all exposed surfaces shall be finished smooth. Concrete pads shall be of 3000 psi strength and shall be set on concrete floor slabs and properly anchored.
- I. The Contractor shall furnish all required foundation sizes, bolts, washers, sleeves, plates and templates for equipment.
- J. The size of the foundation bolts shall be as recommended by the manufacturer.
- K. The type and size of the supporting channels and supplementary steel shall be determined by the Contractor and shall be of sufficient strength and size to allow only a minimum, deflection in conformance with manufacturer's requirements for loading. Contractor shall submit details for approval to the Engineer.

3.12 COORDINATED DRAWINGS

- A. Prior to installation of electrical work in all areas of the building including exposed areas (spaces without ceilings), the Contractor shall prepare completely coordinated layout drawings indicating the coordinated work of all trades involved. The drawings shall be a sheet size similar to the contract drawings. All work shall be to scale minimum $1/4" = 1' - 0"$. The drawings shall include all work shown on the drawings, including equipment (chillers, boilers, air handling units, pumps, water heaters, storage tanks, steam generators, converters, etc), variable frequency controllers, ATC control panels, terminal units, ductwork, air devices, dampers, piping including sprinkler and plumbing, valves, light fixtures, electrical cable trays, raceways and conduits 2" and larger.
- B. All trades shall be responsible for the preparation of the coordinated layout drawings. Each trade shall provide written certification that the coordinated drawings have

accurately incorporated their work, and that all conflicts are resolved or a solution is proposed on the drawings. The Contractor shall schedule the trades accordingly and shall provide final certification that all coordination has been completed.

- C. No work shall be installed prior to the Engineer's approval of the drawings. The Contractor shall submit for approval of the Engineer within 15 days after the award of the contract a schedule of proposed building areas to be grouped for coordination. Upon approval of the schedule, work may commence in areas of the building upon approval of that area's coordinated drawings prior to approval of another area.

3.13 TESTING

- A. Upon completion of the work, the Contractor shall, in the presence of the Engineer, operate, test, adjust, and retest if necessary, the complete electrical system. The system shall function fully and completely as designed.
- B. The Contractor shall furnish all labor, material, supplies, equipment, instruments and power necessary for testing. The tests shall demonstrate the following to the Engineer:
 - 1. That all lighting, power and control circuits are continuous and free from short circuits.
 - 2. That all circuits are free from unspecified grounds.
 - 3. That the insulation resistance-to-ground of all non-grounded circuits is not less than one (1) megohm at 1000 volts D.C.
 - 4. That all circuits and equipment are properly connected in accordance with the applicable wiring diagrams and are operable by demonstrating the functioning of each control device not less than ten (10) times and by continuous operation of each circuit for not less than one-half (1/2) hour.
- C. All defects shall be repaired at once and the tests reconducted at the Contractor's expense.
- D. For the purpose of these tests, normal and emergency conditions may be simulated during these tests if approved by the Engineer. The services of the manufacturer's factory-trained service engineer shall be provided to inspect the installation of all systems and equipment furnished under this division to assure that it is installed in accordance with the manufacturer's instructions, assist with start-up and instruct operating personnel in the operation and maintenance of the equipment.
- E. Also, the following testing procedure shall be made on all equipment operating on 480 volts and below:
 - 1. Circuit breakers of frame size 400 amperes and greater, operating on normal power or equipment branch emergency power, shall be tested utilizing primary current injection. Secondary current injection testing is not acceptable.
 - 2. Circuit breakers of frame size 225 amperes and greater, operating on the life safety branch, critical branch, or unsegregated emergency (generator feeds)

shall be tested utilizing primary current injection. Secondary current injection testing is not acceptable.

3. A random sampling (10%) of all other circuit breakers, minimum of (2) per panelboard, shall be tested using either primary current injection, or if supported by the circuit breaker trip unit, secondary current injection.
 4. Make voltage build-up tests on all equipment and wiring with a voltage sufficient to determine that no short circuits exist.
 5. Make tests of each motor provided under Mechanical Divisions to measure the actual service parameters while the motor is operating at design duty conditions including steady state full load amperes (FLA), voltage and power factor. Make any adjustments to overcurrent protective devices and motor overload elements as required.
 6. All outages for performing tests and adjustments shall be scheduled and coordinated in advance with the Owner.
- F. Results of the above tests shall show the equipment and wiring meets the requirements of this specification before being accepted by the Engineer. Should any of the above tests indicate defects in materials or workmanship, the faulty installation shall be repaired or replaced at once and the tests reconducted at the Contractor's expense. Test results shall be documented and included in the Operating and Maintenance Manual.

3.14 TEMPORARY ELECTRICAL POWER

- A. Provide all temporary electric service for power and lighting including panels, feeders, lighting, outlets, branch circuits, and other similar equipment for required construction.
- B. All temporary work shall be in accordance with the latest OSHA and local jurisdiction safety requirements and shall be completely removed upon completion of the project.
- C. Costs associated with obtaining temporary service and using electrical power for construction via the temporary electrical power system used shall be paid by the Contractor. The Electrical Subcontractor shall be responsible for providing, maintaining, and removing the temporary electrical power system only.

END OF SECTION 26 00 10

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SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.

- B. Related Requirements:

- 1. Section 26 05 23 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2 and 3 control cables.
 - 2. Section 27 15 13 "Communications Copper Horizontal Cabling" for cabling used for voice and data circuits.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Alpha Wire.

2. AFC Cable Systems.
3. Encore Wire Corporation.
4. Cerro Wire.
5. Okonite Company, The.
6. General Cable Technologies Corporation.
7. Southwire Incorporated.

- B. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.
- C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN-2-THWN-2.
- D. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type XHHW-2.
- E. Multiconductor Luminaire Cable: Comply with NEMA WC 70/ICEA S-95-658//UL 1569 for metal-clad cable, Type MC with insulated ground wire and #10 AWG bare aluminum bonding conductor, two #16 insulated for 0-10V dimming signal, aluminum interlocking armor.
1. Type MC cable is not permitted anywhere except from junction box to luminaire fixture.

2.2 CONNECTORS AND SPLICES

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. AFC Cable Systems, Inc.
 2. Gardner Bender.
 3. Hubbell Power Systems, Inc.
 4. Ideal Industries, Inc.
 5. IlSCO; a branch of Barden Corporation.
 6. NSI Industries LLC.
 7. O-Z/Gedney; a brand of the EGS Electrical Group.
 8. 3M; Electrical Markets Division.
 9. TE Connectivity.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- C. All wiring connected to engine generator set shall be stranded.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Exposed Feeders: Type THHN-2-THWN-2, single conductors in raceway.
- B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace (General): Type THHN-2-THWN-2, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace (Normal Power Circuits only, 30 amperes or less): Armored cable, Type AC.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2-THWN-2, single conductors in raceway.
- E. Branch Circuits Exposed: Type THHN-2-THWN-2, single conductors in raceway.
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions (General): Type THHN-2-THWN-2, single conductors in raceway.
- G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2-THWN-2, single conductors in raceway.
- H. Branch Circuit Luminaire Whips, 0-10V dimming: Metal-clad luminaire cable, Type MC with signal conductors.
 - 1. Type MC shall not exceed 30'0".
- I. Branch Circuits Installed below Raised Flooring: Type THHN-2-THWN-2, single conductors in raceway.
- J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls and ceilings, unless otherwise indicated. Cables shall not be installed encased in concrete floor slabs, or below slabs on grade, except where specifically indicated on drawings.
- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."
- G. Complete cable tray systems installation according to Section 26 05 36 "Cable Trays for Electrical Systems" prior to installing conductors and cables.
- H. Wiring shall only be provided as single or combined wiring groups as follows:
 - 1. Multiwire branch circuits are not permitted; when multiple circuits in a single raceway or cable assembly are installed, a separate phase and grounded (neutral) circuit conductor shall be routed from the respective indicated space or pole numbers in the schedule for the panelboard, to the associated utilization point, device, or outlet.
 - 2. Wiring shall only be provided as single or combined wiring groups as follows:
 - a. Multiwire branch circuits are not permitted; when multiple circuits in a single raceway or cable assembly are installed, a separate phase and grounded (neutral) circuit conductor shall be routed from the respective indicated space or pole numbers in the schedule for the panelboard, to the associated utilization point, device, or outlet.
 - 3. Where multiple branch circuits are routed in a single raceway or cable assembly, a shared equipment grounding conductor shall be permitted, except for circuits serving isolated ground receptacles or unless otherwise indicated.
 - 4. The contractor shall review each utilization device or equipment for connection requirements and provide neutral conductor if required.
 - 5. One section of conduit (raceway) shall not enclose more than three single-phase branch circuits, one three-phase branch circuit, or one feeder (three phase or single phase), unless otherwise indicated.
 - 6. Wiring size shall be #12 AWG minimum for a typical 20 ampere, 120 volt or 277 volt lighting or receptacle branch circuit with a maximum total length of 90 feet

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and 225 feet, respectively. When circuit total lengths exceed those limits (measured horizontally and vertically along the path from the Panelboard to the load) wiring size (including phase, neutral, and equipment grounding conductors) shall be increased from the sizes indicated in the panel schedules as follows:

120V to Ground		277V to Ground	
Size	Max. Total Length	Size	Max. Total Length
#12	90'	#12	225'
#10	150'	#10	375'
#8	over 150'	#8	over 375'

- I. Emergency power branch circuits/feeders shall not be routed in the same raceway system as normal power branch circuits/feeders. Additionally, branch circuits/feeders originating from critical and life safety branch panelboards shall not be routed in raceway systems originating from other panelboards, whether of the same branch or not.
- J. No wiring shall be installed until the building is under roof. Do not install wire in raceways until after concrete work or plastering is completed. All raceways in which moisture has collected must be swabbed out before pulling in wire. Insulation resistance to ground must not be less than one megohm.
- K. Wiring exposed to temperatures higher than 30°C (Celsius) shall have insulation properly rated for the temperatures it must withstand (i.e., wiring in lighting fixtures or electric heating equipment unless provided by the fixture or equipment manufacturer shall be type THHN, AVB, or other as needed).
- L. "Green Wire" grounding and neutral wires shall be color coded throughout their entire length. Phase wires may be color coded throughout their entire length or may be color coded by applied sleeves or tape at each splice and termination and at a maximum interval of 3' for any accessible segment. Color coding shall be as follows:

208Y/120V 480Y/277V

PHASE A	BLACK	BROWN
PHASE B	RED	ORANGE
PHASE C	BLUE	YELLOW
NEUTRAL	WHITE	GRAY
GROUNDING	GREEN	GREEN

- M. Green colored insulated equipment grounding conductors shall be provided for all feeders and for all branch circuits. Provide a "Green Wire" grounding conductor in addition to grounding provided by the raceway system enclosing the branch circuit or circuits. The size of the "Green Wire" grounding conductor shall be as indicated on the drawings, and shall interconnect the grounding terminal of each receptacle, lighting fixture or equipment enclosure containing the circuit and the grounding bus or terminal at the point of origin or the respective circuit. The "Green Wire" grounding conductor shall be run with each respective feeder or branch circuit conductor group. At each

receptacle location, connect the "Green Wire" system to the receptacle enclosure using a separate pigtail.

- N. All wiring whose voltage exceeds 100 volts with respect to ground shall be protected by enclosing it in a raceway. All low voltage wiring not protected by raceway shall be rated for the application (e.g. plenum rated cable, etc.).
- O. Communications, signaling, fire alarm, Class 2 cabling, etc. shall not be installed in the same raceways as line voltage power circuits.

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Screw-on "Wirenut" type fittings shall not be used for connecting stranded wiring unless the strands are twisted for each conductor before installing the "wirenut". Aluminum fittings shall not be used for wire splices, termination or any wire connections. When stranded wires are to be terminated in a screw pressure connection, carefully selected fittings and installation methods shall be used to avoid the problem of separating strands.
- C. No splices or joints shall be permitted in either feeders or branches except at outlets or accessible junction boxes. Joints in branch circuits shall be mechanically and electrically secured with solderless connectors as listed by Underwriters' Laboratories, Inc., as pressure cable type, 600-volt rating, compression or indent type. Connectors shall be insulated by integral or separate cover, or by means of taping with approved plastic or rubber friction tapes to provide insulating value equal to that of the conductors being joined. In the making of a splice, connectors shall be brought up securely upon the conductor in a workmanlike manner in such a way that all conductors are equally engaged, the insulation is not ruptured, no bare wires are exposed or have "back-off" due to the application of pressure, and the connector will not loosen due to cycling or vibration. The number, size and combinations of conductors permitted by the Underwriters' Laboratories, Inc., as listed on manufacturers' packaging of the connector shall be strictly complied with. Wires, No. 8 AWG and smaller, shall be twisted together with a minimum of one turn of the stripped conductors before insertion into connectors. Splice connectors shall be of a type and be so installed that the conductor insulation will not be reduced when the conductor is positioned in its final operating position. Tools used to compress these fittings shall be the type that requires proper compression before the tool can be released.
- D. All insulating materials for splices, connections, etc. such as rubber, friction, glass and synthetic tapes, putties, resins, splice cases, compositions, and similar materials shall be of the type approved for the particular use, location, voltage, and similar applicable requirements and shall be applied and installed in an approved manner, all in accordance with the manufacturer's recommendations.
- E. Make splices, terminations, and taps that are compatible with conductor material.

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- F. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test feeder conductors for compliance with requirements.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
 - a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
 - b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- B. Test and Inspection Reports: Prepare a written report to record the following:

1. Procedures used.
 2. Results that comply with requirements.
 3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- C. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION 26 05 19

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SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: Grounding systems and equipment.
- B. Section includes grounding systems and equipment, plus the following special applications:
 - 1. Underground distribution grounding.
 - 2. Ground bonding common with lightning protection system.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:
 - 1. Test wells.
 - 2. Ground rods.
 - 3. Ground rings.
 - 4. Grounding arrangements and connections for separately derived systems.
 - 5. Grounding for sensitive electronic equipment.
- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Instructions for periodic testing and inspection of grounding features at test wells, ground rings, and grounding connections for separately derived systems based on NETA MTS.
 - a. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
 - b. Include recommended testing intervals.

1.6 QUALITY ASSURANCE

- A. 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.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 1. Solid Conductors: ASTM B 3.
 2. Stranded Conductors: ASTM B 8.
 3. Tinned Conductors: ASTM B 33.
 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

2.2 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 inch diameter by 10 feet in length.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 4/0 AWG minimum.
 - 1. Bury at least 24 inches below grade.
- C. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor; connect to horizontal bus.
- D. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.

4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 4/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.
- D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 4/0 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.3 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. All equipment grounding conductors, bonding jumpers, and grounding electrode conductors installed in metallic raceways shall be bonded to the raceway with bonding bushings at enclosures and equipment, such as panelboards, switchboards, pullboxes, and meter sockets.
- C. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 1. Feeders and branch circuits.
 2. Lighting circuits.
 3. Receptacle circuits.
 4. Single-phase motor and appliance branch circuits.
 5. Three-phase motor and appliance branch circuits.
 6. Flexible raceway runs.
 7. Armored and metal-clad cable runs.

8. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
- D. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- E. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- F. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.
 1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch grounding bus.
 3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- G. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.4 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. All grounding electrodes present within a building or structure shall be bonded together in accordance with NFPA 70 250.50.
- C. Grounding and bonding conductors, interior locations: Conductors shall be permitted to be exposed only within electrical rooms. Where routed in other locations, conductors shall be installed in metallic raceways with bonding bushings at each end, enclosure pull and junction box entrances.
- D. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

- E. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 - 2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- F. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.
 - 1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- G. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- H. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- I. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.
- J. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4/0 AWG.

1. Concrete foundation utilized for electrode installation shall be in direct contact with the earth, with no intervening vapor barriers or gravel layers.
2. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
3. Bond grounding conductor to reinforcing steel every 24" in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

3.5 LABELING

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for instruction signs. The label or its text shall be green.
- B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.
 1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells[, and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- C. Grounding system will be considered defective if it does not pass tests and inspections.

- D. Prepare test and inspection reports.
- E. Report measured ground resistances that exceed the following values:
 - 1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 5 ohms.
 - 2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
 - 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
 - 4. Power Distribution Units or Panelboards Serving Data Center, Telecommunications Rooms/Closets: 1 ohm(s).
 - 5. Substations and Pad-Mounted Equipment: 5 ohms.
 - 6. Manhole Grounds: 10 ohms.
- F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze hangers. Include Product Data for components.

2. Steel slotted channel systems. Include Product Data for components.
3. Equipment supports.

1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.7 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

1.8 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation; Kindorf.
 - f. Unistrut.
 - g. Wesanco, Inc.
 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 3. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

- C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 - 2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 - 3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 - 4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 - 5. Toggle Bolts: All-steel springhead type.
 - 6. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 50 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with single-bolt conduit clamps.
- D. Conduits, cable trays, boxes and fittings shall be hung from the building structure with metal supports. No electrical items shall be hung from pipes or ductwork.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.

6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 7. To Light Steel: Sheet metal screws.
 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

- B. Touchup: Comply with requirements in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29

SECTION 26 05 33

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal conduits, tubing, and fittings.
 - 2. Nonmetal conduits, tubing, and fittings.
 - 3. Metal wireways and auxiliary gutters.
 - 4. Nonmetal wireways and auxiliary gutters.
 - 5. Surface raceways.
 - 6. Boxes, enclosures, and cabinets.
- B. Related Requirements:
 - 1. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
 - 2. Section 270528 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.

1.3 DEFINITIONS

- A. GRC: Galvanized rigid steel conduit.
- B. IMC: Intermediate metal conduit.
- C. EMT: Electrical metallic tubing.
- D. FMC: Flexible metal conduit.
- E. LTFMC: Liquid-tight flexible metal conduit.
- F. RNC: Rigid Non-Metallic Conduit.

1.4 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 - 1. Structural members in paths of conduit groups with common supports.
 - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
- B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Allied Tube & Conduit.
 - 3. Anamet Electrical, Inc.
 - 4. Electri-Flex Company.
 - 5. O-Z/Gedney; a brand of EGS Electrical Group.
 - 6. Picoma Industries, a subsidiary of Mueller Water Products, Inc.
 - 7. Republic Conduit.
 - 8. Southwire Company.
 - 9. Thomas & Betts Corporation.
 - 10. Western Tube and Conduit Corporation.
 - 11. Wheatland Tube Company; a division of John Maneely Company.
- B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. GRC: Comply with ANSI C80.1 and UL 6. Raceways with integral "quick fit" couplings are not permitted.
- D. IMC: Comply with ANSI C80.6 and UL 1242. Raceways with integral "quick fit" couplings are not permitted.

- E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
 - 1. Comply with NEMA RN 1.
 - 2. Coating Thickness: 0.040 inch, minimum.
- F. EMT: Comply with ANSI C80.3 and UL 797. Raceways with integral "quick fit" couplings are not permitted.
- G. FMC: Comply with UL 1; zinc-coated steel; aluminum for use with ARC and EMTA raceway systems.
- H. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B. Match raceway material.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 - 2. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Setscrew.
 - 3. Expansion Fittings: Steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
- J. Joint Compound for IMC, GRC,: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cooper B-Line, Inc.
 - 2. Hoffman; a Pentair company.
 - 3. Mono-Systems, Inc.
 - 4. Square D; a brand of Schneider Electric.
 - 5. Wiremold.
 - 6. Equity Industries.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
 - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Screw-cover type unless otherwise indicated.

- E. Finish: Manufacturer's standard enamel finish.
- F. Tele-Power Poles:
 - 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. Mono-Systems, Inc.
 - b. Panduit Corp.
 - c. Wiremold / Legrand.
 - 2. Material: Galvanized steel with ivory baked-enamel finish.
 - 3. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.3 BOXES, ENCLOSURES, AND CABINETS

- 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. Adalet.
 - 2. Cooper Technologies Company; Cooper Crouse-Hinds.
 - 3. EGS/Appleton Electric.
 - 4. Erickson Electrical Equipment Company.
 - 5. FSR Inc.
 - 6. Hoffman; a Pentair company.
 - 7. Hubbell Incorporated; Killark Division.
 - 8. Kraloy.
 - 9. Milbank Manufacturing Co.
 - 10. Mono-Systems, Inc.
 - 11. O-Z/Gedney; a brand of EGS Electrical Group.
 - 12. RACO; a Hubbell Company.
 - 13. Spring City Electrical Manufacturing Company.
 - 14. Thomas & Betts Corporation.
 - 15. Wiremold / Legrand.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- E. Metal Floor Boxes:
 - 1. Material: Cast metal or sheet metal.
 - 2. Type: Fully adjustable.
 - 3. Shape: Rectangular.
 - 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb . Outlet boxes designed for attachment of luminaires weighing more than 50 lb. shall be listed and marked for the maximum allowable weight.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, with gasketed cover.
- I. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- J. Device Box Dimensions: Minimum 4" square.
- K. Gangable boxes are prohibited.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
 - 1. Exposed Conduit: GRC.
 - 2. Concealed Conduit, Aboveground: GRC.
 - 3. Underground Conduit: Refer to Section 260543 "Underground Ducts and Raceways for Electrical Systems"
 - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: EMT.
 - 2. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - d. Sally port
 - 3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 - 5. Damp or Wet Locations: GRC.
 - 6. Boxes and Enclosures: NEMA 250, Type 1
- C. Minimum Raceway Size: 3/4-inch (21-mm) trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use setscrew, steel fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within 12 inches of enclosures to which attached.
- I. Raceways Embedded in Slabs:
 1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot (3-m) intervals.
 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 3. Arrange raceways to keep a minimum of 1 inch (25 mm) of concrete cover in all directions.
 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
- J. Stub-ups to Above Recessed Ceilings:

1. Use EMT for raceways.
 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- L. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- Q. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- R. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- S. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- T. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service raceway enters a building or structure.
 3. Where otherwise required by NFPA 70.
- U. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- V. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- W. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- X. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- Y. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- Z. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- AA. Locate boxes so that cover or plate will not span different building finishes.
- BB. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

- CC. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- DD. Set metal floor boxes level and flush with finished floor surface.
- EE. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.4 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33

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SECTION 26 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks.
 - 2. Handholes and boxes.

1.3 DEFINITION

- A. RNC: Rigid nonmetallic conduit.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Duct-bank materials, including separators and miscellaneous components.
 - 2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 - 3. Accessories for manholes, handholes, boxes.
 - 4. Warning tape.
- B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:
 - 1. Duct entry provisions, including locations and duct sizes.
 - 2. Reinforcement details.
 - 3. Frame and cover design and manhole frame support rings.
 - 4. Grounding details.
 - 5. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
 - 6. Joint details.

- C. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:
 - 1. Duct entry provisions, including locations and duct sizes.
 - 2. Cover design.
 - 3. Grounding details.
 - 4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.5 INFORMATIONAL SUBMITTALS

- A. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
 - 1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
 - 2. Drawings shall be signed and sealed by a qualified professional engineer.
- B. Product Certificates: For concrete and steel used in precast concrete handholes, as required by ASTM C 858.

1.6 QUALITY ASSURANCE

- A. Comply with ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with all applicable requirements of serving electrical utilities.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
- B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- C. Lift and support precast concrete units only at designated lifting or supporting points.

1.8 COORDINATION

- A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.
- B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by

coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Rigid Steel Conduit (RGS): Galvanized. Comply with ANSI C80.1.
- B. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ARNCO Corp.
 - 2. Beck Manufacturing.
 - 3. Cantex, Inc.
 - 4. CertainTeed Corp.; Pipe & Plastics Group.
 - 5. Champion Fiberglass.
 - 6. Condux International, Inc.
 - 7. ElecSys, Inc.
 - 8. Electri-Flex Company.
 - 9. IPEX Inc.
 - 10. Lamson & Sessions; Carlon Electrical Products.
 - 11. Manhattan/CDT; a division of Cable Design Technologies.
 - 12. Spiraduct/AFC Cable Systems, Inc.
 - 13. United Fiberglass of America
 - 14. TE Connectivity / Raychem
- C. Duct Accessories:
 - 1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
 - 2. Warning Tape:
 - a. Detectable three-layer laminate, consisting of printed pigmented polyolefin film, solid aluminum-foil core, and clear protective film that allows inspection of continuity of conductive core; bright colored, continuous-

- printed on one side with inscription of utility compounded for direct-burial service.
- b. Width: 3 inch.
- c. Overall Thickness: 5 mil.
- d. Foil Core Thickness: 0.35 mil.
- e. Weight: 28 lb/1000 sq. ft.
- f. Tensile in accordance with ASTM D882: 70 lbf (311.3 N) and 4600 psi (31.7 MPa).
- 3. Duct plugs: Plugs in all unused ducts shall be rubber stopper type, water and gas tight, with eye for retaining pull rope.

2.3 PRECAST CONCRETE HANDHOLES AND BOXES

- 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. Smith-Midland.
 - 2. Oldcastle Precast Group.
 - 3. Riverton Concrete Products; a division of Cretex Companies, Inc.
 - 4. Utility Concrete Products, LLC.
 - 5. Utility Vault Co.
 - 6. Wausau Tile, Inc.
- B. Comply with ASTM C 858 for design and manufacturing processes.
- C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
 - 1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
 - 2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 3. Cover Legend: Molded lettering, "ELECTRIC." or "TELEPHONE."
 - 4. Configuration: Units shall be designed for flush burial and have integral closed bottom, unless otherwise indicated.
 - 5. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

6. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.4 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Description: Comply with SCTE 77.

1. Color: Green.
2. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC." or "TELEPHONE."
6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. CDR Systems Corporation.
 - d. NewBasis.
 - e. Hubbell Quazite

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

- A. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.
- B. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.
- C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank or single ducts as applicable, unless otherwise indicated.

- D. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.
- E. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC installed in direct-buried duct bank, unless otherwise indicated.
- F. Underground Ducts for Telephone, Communications, or Data Circuits: RNC, NEMA EPC-40-PVC, in direct buried single ducts, unless otherwise indicated.
- G. Underground Ducts Crossing Paved Paths, Paved Parking Areas, and Roadways: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.
- H. Underground Ducts within Thermal Treatment Zones: Rigid Steel Conduit (RGS).

3.2 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:
 - 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20] [Polymer concrete, SCTE 77, Tier 15 structural load rating.
 - 3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer concrete units, SCTE 77, Tier 8 structural load rating.
 - 4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.

3.3 EARTHWORK

- A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."

- D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Section 017329 "Cutting and Patching."

3.4 DUCT INSTALLATION

- A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.
- B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations, unless otherwise indicated.
- C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
 - 2. Grout end bells into structure walls from both sides to provide watertight entrances.
- E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
- F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- G. Pulling Cord: Install 100-lbf- test nylon cord in ducts, including spares.
- H. Concrete-Encased Ducts: Support ducts on duct separators.
 - 1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 - 2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

- a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.
 3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
 4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
 5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
 6. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.
 7. Depth: Install top of duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
 8. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
 9. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.
- I. Direct-Buried Duct Banks:
1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
 2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct

- movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes less than 6 inches in nominal diameter.
 4. Install backfill as specified in Section 312000 "Earth Moving."
 5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
 6. Install ducts with a minimum of 3 inches between ducts for like services and 6 inches between power and signal ducts.
 7. Depth: Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated.
 8. Set elevation of bottom of duct bank below the frost line.
 9. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

3.5 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Cast-in-Place Manhole Installation:

1. Finish interior surfaces with a smooth-troweled finish.
2. Windows for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches thick, arranged as indicated.
3. Cast-in-place concrete, formwork, and reinforcement are specified in Section 033000 "Cast-in-Place Concrete."

B. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891, unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
3. Install handholes with bottom below the frost line.
4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

E. Manhole Access: Circular opening in manhole roof; sized to match cover size.

1. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

F. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.

G. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

H. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.6 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install handholes and boxes with bottom below the frost line.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

- F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.7 GROUNDING

- A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
 - 2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
 - 3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.9 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 26 05 43

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SECTION 26 05 44

SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
 - 2. Sleeve-seal systems.
 - 3. Sleeve-seal fittings.
 - 4. Grout.
 - 5. Silicone sealants.

- B. Related Requirements:

- 1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Wall Sleeves:

- 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
 - 2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- F. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized sheet steel.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Advance Products & Systems, Inc.
 - b. CALPICO, Inc.
 - c. Metraflex Company (The).
 - d. Pipeline Seal and Insulator, Inc.
 - e. Proco Products, Inc.
 - 2. Sealing Elements: Nitrile (Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: Carbon steel.
 - 4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Presealed Systems.
 - b. Approved Equal

2.4 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi , 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4 inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Sleeves shall be flush with finished floors, and extended 2" above finished floor level in kitchens, equipment rooms, and wet floor areas. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.

- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 26 05 44

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SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Identification for raceways.
 - 2. Identification of power and control cables.
 - 3. Identification for conductors.
 - 4. Underground-line warning tape.
 - 5. Warning labels and signs.
 - 6. Instruction signs.
 - 7. Equipment identification labels.
 - 8. Miscellaneous identification products.

1.3 ACTION SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.

- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER AND CONTROL RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
 - 1. Black letters on a white field.
 - 2. Legend: Indicate voltage and system or service type.
- C. Colors for Raceways Carrying Circuits at More Than 600 V:
 - 1. Black letters on an orange field.
 - 2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING."; indicate voltage.
- D. Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.
- E. Write-On Tags: Polyester tag, 0.010 inches thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Label for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.2 METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.

- B. Colors for Cables Carrying Circuits at 600 V and Less:
 - 1. Black letters on a white field.
 - 2. Legend: Indicate voltage and system or service type.
- C. Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.

2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.
- B. Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.
- C. Self-Adhesive, Self-Laminating Polyester Labels: Preprinted, 3 mil- thick flexible label with acrylic pressure-sensitive adhesive that provides a clear, weather- and chemical-resistant, self-laminating, protective shield over the legend. Labels sized to fit the cable diameter such that the clear shield overlaps the entire printed legend.
- D. Write-On Tags: Polyester tag, 0.0100 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Label for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- B. Self-Adhesive, Self-Laminating Polyester Labels: Preprinted, 3 mil- thick flexible label with acrylic pressure-sensitive adhesive that provides a clear, weather- and chemical-resistant, self-laminating, protective shield over the legend. Labels sized to fit the conductor diameter such that the clear shield overlaps the entire printed legend.
- C. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around conductor it identifies. Full shrink recovery at a maximum of 200 deg F (93 deg C). Comply with UL 224.
- D. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- E. Write-On Tags: Polyester tag, 0.0100 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Labels for Tags: Self-adhesive label, machine-printed with permanent, waterproof, black ink recommended by printer manufacturer, sized for attachment to tag.

2.5 FLOOR MARKING TAPE

- A. 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

2.6 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE,.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

C. Tag: Branch Circuits

1. Pigmented polyolefin, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Thickness: 4 mils.
3. Weight: 18.5 lb/1000 sq. ft. .
4. 3-Inch (75-mm) Tensile According to ASTM D 882: 30 lbf, and 2500 psi.

D. Tag: Feeders and service conductors

1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Overall Thickness: 5 mils.
3. Foil Core Thickness: 0.35 mil
4. Weight: 28 lb/1000 sq. ft.
5. 3-Inch Tensile According to ASTM D 882: 70 lbf , and 4600 psi .

2.7 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
- C. Baked-Enamel Warning Signs:
 - 1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
 - 2. 1/4-inch grommets in corners for mounting.
 - 3. Nominal size, 7 by 10 inches.
- D. Metal-Backed, Butyrate Warning Signs:
 - 1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
 - 2. 1/4-inch grommets in corners for mounting.
 - 3. Nominal size, 10 by 14 inches.
- E. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES ."
 - 3. Arc Flash Hazard signs: "WARNING – ARC FLASH AND SHOCK HAZARD PRESENT – APPROPRIATE PPE REQUIRED", with indications for hazard boundary, working distance, incident energy, approach boundary, voltage, PPE category/description, and date of analysis. For equipment with main circuit breaker, provide individual signs for line and load side of circuit breaker.
 - 4. Available fault current signs: "AVAILABLE FAULT CURRENT:", with calculated fault current in 3-phase amperes symmetrical, steady state, X/R ratio, and date of calculation.

2.8 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
 - 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.9 EQUIPMENT IDENTIFICATION LABELS

- A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.
- B. Embossed plastic tape labels are not to be used.

2.10 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 deg F , According to ASTM D 638: 12,000 psi.
 - 3. Temperature Range: Minus 40 to plus 185 deg F .
 - 4. Color: Black except where used for color-coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 deg F , According to ASTM D 638: 12,000 psi.
 - 3. Temperature Range: Minus 40 to plus 185 deg F .
 - 4. Color: Black.
- C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 deg F , According to ASTM D 638: 7000 psi .
 - 3. UL 94 Flame Rating: 94V-0.
 - 4. Temperature Range: Minus 50 to plus 284 deg F .
 - 5. Color: Black.

2.11 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify identity of each item before installing identification products.

- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- F. Attach plastic raceway and cable labels that are not self-adhesive type with clear vinyl tape with adhesive appropriate to the location and substrate.
- G. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.
- H. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
- I. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

- A. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers over orange background that extends full length of raceway or duct and is 12 inches (300 mm) wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- (75-mm-) high black letters on 20-inch (500-mm) centers. Stop stripes at legends. Apply to the following finished surfaces:
 - 1. Floor surface directly above conduits running beneath and within 12 inches (300 mm) of a floor that is in contact with earth or is framed above unexcavated space.
 - 2. Wall surfaces directly external to raceways concealed within wall.
 - 3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
- B. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Identify with self-adhesive vinyl label. Install labels at 10-foot (3-m) maximum intervals.
- C. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Emergency Power.
 2. Power.
- D. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.
 - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
 - b. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - c. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- E. Power-Circuit Conductor Identification, More than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use write-on tags.
- F. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- G. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive vinyl labels with the conductor or cable designation, origin, and destination.
- H. Control-Circuit Conductor Termination Identification: For identification at terminations provide heat-shrink preprinted tubes with the conductor designation.
- I. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.
- J. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- K. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
1. Limit use of underground-line warning tape to direct-buried cables.
 2. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- L. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- M. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
1. Comply with 29 CFR 1910.145.
 2. Identify system voltage with black letters on an orange background.
 3. Apply to exterior of door, cover, or other access.
 4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.
- N. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- O. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer or source selection.
- P. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
1. Labeling Instructions:
 - a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.

- b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
- c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
- d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
- e. Label legend shall include: equipment designation, branch of power (normal, emergency, emergency critical branch, emergency life safety branch, emergency equipment branch, UPS, standby, etc.) in corresponding facility standard color code, voltage/phase, and the panel/circuit number of the source feeding the equipment.
- f. Panel labels/identifiers shall be labeled with above mentioned items and number of room in which they are located.

2. Equipment to Be Labeled:

- a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, engraved, laminated acrylic or melamine label.
- b. Enclosures and electrical cabinets.
- c. Access doors and panels for concealed electrical items.
- d. Switchgear.
- e. Switchboards.
- f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
- g. Substations.
- h. Emergency system boxes and enclosures.
- i. Enclosed switches.
- j. Enclosed circuit breakers.
- k. Enclosed controllers.
- l. Variable-speed controllers.
- m. Push-button stations.
- n. Power transfer equipment.
- o. Contactors.
- p. Remote-controlled switches, dimmer modules, and control devices.
- q. Power-generating units.
- r. Monitoring and control equipment.

END OF SECTION 26 05 53

SECTION 26 05 73

OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

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 computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study.
- B. No electrical equipment requiring overcurrent protective devices, or having a short circuit withstand rating, shall be released for fabrication prior to the review and approval of the study.**
- C. Where required by applicable code (emergency systems, code mandated standby systems, elevators, etc.) systems shall be fully coordinated, including in the instantaneous region. Any overlap of time-current characteristics of successive devices is unacceptable, and where necessary, changes in the distribution devices or system configuration to correct shall be provided at no additional cost.**

1.3 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.
1. Coordination-study input data, including completed computer program input data sheets.
 2. Study and Equipment Evaluation Reports.
 3. Coordination-Study Report.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For coordination-study specialist.

B.Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

1.5 QUALITY ASSURANCE

A.Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B.Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

2. The engineer of record shall submit a verification letter with the approved study, sealed and signed, certifying that the study meets all requirements of the applicable codes, standards, and contract documents.

C. Studies shall be performed by one of the following firms:

1. Coordinated Power Engineering, Inc.
2. MET Electrical Testing
3. Reuter-Hanney Corporation
4. Square D Corporation, a division of Schneider Electric
5. Eaton Electrical Services & Systems

D. Comply with all applicable requirements of the NEC, including but not limited to the requirements found in Articles 110, 215, 230, 240, 517, 620, 695, 700, 701 and 708.

E. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

F. Comply with IEEE 399 for general study procedures.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A.Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:

B.Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:

- C. Subject to compliance with requirements, utilize products of one of the following, or a comparable product:
1. CGI CYME.
 2. EDSA Micro Corporation.
 3. ESA Inc.
 4. Operation Technology, Inc.
 5. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
1. Optional Features:
- a. Arcing faults.
 - b. Simultaneous faults.
 - c. Explicit negative sequence.
 - d. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

- A. Scope: The power system protection analyses shall encompass the distribution system provided or modified under the project, back to all utility or generator sources. Where existing distribution system elements are connected, at a minimum the first connected bus or apparatus downstream of new or modified circuit elements shall be included.

B. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other electrical Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Impedance of utility service entrance. The Contractor shall coordinate with the serving utility for short circuit current availability at the site. Use of "infinite bus" utility source as an assumption, in lieu of actual utility availability, is not acceptable without written permission from the Architect.
3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit-breaker and fuse-current ratings and types.
 - b. Relays and associated power and current transformer ratings and ratios.
 - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - d. Generator kilovolt amperes, size, voltage, and source impedance.
 - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
 - f. Busway ampacity and impedance.
 - g. Motor horsepower and code letter designation according to NEMA MG 1.
4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Generator thermal-damage curve.
 - e. Ratings, types, and settings of utility company's overcurrent protective devices.
 - f. Special overcurrent protective device settings or types stipulated by utility company.
 - g. Time-current-characteristic curves of devices indicated to be coordinated.
 - h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
 - i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
 - j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

- A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
1. Switchgear and switchboard bus.
 2. Medium-voltage controller.
 3. Motor-control center.
 4. Distribution panelboard.
 5. Branch circuit panelboard.
- B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with and IEEE 242.
1. Transformers:
 - a. ANSI C57.12.10.
 - b. ANSI C57.12.22.
 - c. ANSI C57.12.40.
 - d. IEEE C57.12.00.
 - e. IEEE C57.96.
 2. Medium-Voltage Circuit Breakers: IEEE C37.010.
 3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
 4. Low-Voltage Fuses: IEEE C37.46.
- E. Study Report:
1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
 2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.
- F. Equipment Evaluation Report:
1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.

3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.

1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
3. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 141, IEEE 241, and IEEE 242 recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

- a. Inrush current when first energized.
- b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
- c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

F. Low voltage switchgear circuit breakers with static trip units shall be configured with instantaneous trip turned "OFF" wherever practicable, to maximize selective coordination with downstream devices.

G. "I²T" settings, where present, shall be coordinated in the "OFF"/"OUT" position, to provide enhanced arc flash protection. Where selective coordination requires "I²T" activation, notify the architect in writing prior to completion of study for direction.

H. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:

- a. Device tag.
- b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
- c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
- d. Fuse-current rating and type.
- e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

- a. Device tag.
- b. Voltage and current ratio for curves.
- c. Three-phase and single-phase damage points for each transformer.
- d. No damage, melting, and clearing curves for fuses.
- e. Cable damage curves.
- f. Transformer inrush points.
- g. Maximum fault-current cutoff point.

I. Completed data sheets for setting of overcurrent protective devices.

3.5 ARC FLASH HAZARD ANALYSIS

A. Perform calculations in accordance with NFPA 70E and IEEE 1584, to determine applicable arc flash incident energy at each bus or device. Calculations shall be performed at all significant locations of arc fault energy, including all 480/277 volt busses and 208/120 or 240 volt busses fed by transformers 100KVA or greater. For equipment equipped with a main or input circuit breaker, separate calculations shall be performed on the line and load side of the circuit breaker. Tabulate recommendations for required personnel protective equipment (PPE), and label all equipment with approved labels.

B. Arc flash labels shall comply with OSHA requirements, and shall be durable and suitable for the environmental conditions in the area of installation. Labels shall indicate "Warning" or "Danger" (for voltages over 600V or incident energy greater than 40 cal/cm²), incident energy at corresponding working distance, minimum arc rating in calories per square centimeter, arc flash boundary distance PPE category 1 thru 4, limited / restricted approach shock hazard boundaries, and voltage level shock risk. Labels shall include an information field with the bus name, date of the study, and protective device (including location if remote) used to obtain the arc fault calculations.

- C. Devices to be analyzed shall include all devices and equipment which are likely to require personnel interaction while energized for operations, inspection, infrared scanning and maintenance, including but not limited to: Enclosed circuit breakers, enclosed safety switches, transformers, motor controllers, elevator controllers, and package equipment control. Devices analyzed shall include equipment furnished under other divisions, existing equipment, and owner-furnished equipment as applicable.
- D. For all busses with calculated PPE requirement of 3 or higher, provide a separate tabulation of recommend maintenance settings that will reduce the required PPE to lowest level achievable, while temporarily sacrificing selective coordination.
- E. Circuit Protective Devices: The Contractor shall calibrate, adjust, set and test each new adjustable circuit protective device to ensure that they will function properly prior to the initial energization of the new power system under actual operating conditions.

END OF SECTION 26 05 73

SECTION 26 09 23

LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Time switches.
2. Photoelectric switches.
3. Standalone daylight-harvesting switching controls.
4. Indoor occupancy sensors.
5. Outdoor motion sensors.
6. Emergency shunt relays.

- B. Related Requirements:

1. Section 262726 "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.
 1. Interconnection diagrams showing field-installed wiring.
 2. 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 each type of lighting control device to include in emergency, operation, and maintenance manuals.

1.6 WARRANTY

- A. Provide 5-year extended manufacturer warranty for all occupancy sensors.
- B. Provide 2-year manufacturer warranty for all daylighting controls.
- C. The warranty period shall start at the date of overall substantial completion for the project.
- D. Submit a sample warranty for approval before purchasing equipment.
- E. See section 01 77 00 – Closeout Procedures for additional warranty requirements.

PART 2 - PRODUCTS

2.1 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cooper Industries, Inc.
 - 2. Intermatic, Inc.
 - 3. NSi Industries LLC; TORK Products.
 - 4. Tyco Electronics; ALR Brand.
- B. Description: Solid state, with SPST dry contacts rated for 1800 VA, to operate connected load, complying with UL 773.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.
 - 3. Time Delay: Thirty-second minimum, to prevent false operation.
 - 4. Lightning Arrester: Air-gap type.
 - 5. Mounting: Twist lock complying with NEMA C136.10, with base.

2.2 DAYLIGHT-HARVESTING SWITCHING CONTROLS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cooper Industries, Inc.
 - 2. Eaton Corporation.
 - 3. Hubbell Building Automation, Inc.
 - 4. Leviton Mfg. Company Inc.
 - 5. Lithonia Lighting; Acuity Lighting Group, Inc.
 - 6. NSi Industries LLC; TORK Products.
 - 7. Sensor Switch, Inc.

8. Tyco Electronics; ALR Brand.
9. Watt Stopper.
10. Crestron.

B. Ceiling-Mounted Switching Controls: Solid-state, light-level sensor unit, with separate power pack, to detect changes in indoor lighting levels that are perceived by the eye.

C. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
3. Sensor Output: Contacts rated to operate the associated power pack, complying with UL 773A. Sensor is powered by the power pack.
4. Power Pack: Dry contacts rated for 20-A ballast load at 120- Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
5. General Space Sensors Light-Level Monitoring Range: 10 to 200 fc, with an adjustment for turn-on and turn-off levels within that range.
6. Atrium Space Sensors Light-Level Monitoring Range: 100 to 1000 fc, with an adjustment for turn-on and turn-off levels within that range.
7. Skylight Sensors Light-Level Monitoring Range: 1000 to 10,000 fc, with an adjustment for turn-on and turn-off levels within that range.
8. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.
9. Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.
10. Test Mode: User selectable, overriding programmed time delay to allow settings check.
11. Control Load Status: User selectable to confirm that load wiring is correct.
12. Indicator: Two digital displays to indicate the beginning of on-off cycles.

2.3 DAYLIGHT-HARVESTING DIMMING CONTROLS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper Industries, Inc.
2. Hubbell Building Automation, Inc.
3. Leviton Mfg. Company Inc.
4. Lithonia Lighting; Acuity Lighting Group, Inc.
5. Watt Stopper.
6. Crestron.

B. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.

1. Lighting control set point is based on two lighting conditions:
 - a. When no daylight is present (target level).

- b. When significant daylight is present.
- 2. System programming is done with two hand-held, remote-control tools.
 - a. Initial setup tool.
 - b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.
- C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with separate controller unit, to detect changes in lighting levels that are perceived by the eye.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Sensor Output: 0- to 10-V dc to operate electronic dimming ballasts. Sensor is powered by controller unit.
 - 3. Power Pack: Sensor has 24-V dc, Class 2 power source, as defined by NFPA 70.
 - 4. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc.

2.4 INDOOR OCCUPANCY SENSORS

- 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. Bryant Electric; a Hubbell company.
 - 2. Cooper Industries, Inc.
 - 3. Hubbell Building Automation, Inc.
 - 4. Leviton Mfg. Company Inc.
 - 5. Lightolier Controls.
 - 6. Lithonia Lighting; Acuity Lighting Group, Inc.
 - 7. Lutron Electronics Co., Inc.
 - 8. NSi Industries LLC; TORK Products.
 - 9. RAB Lighting.
 - 10. Sensor Switch, Inc.
 - 11. Square D; a brand of Schneider Electric.
 - 12. Watt Stopper.
 - 13. Crestron.
- B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - 3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.

4. Power Pack: Dry contacts rated for 20-A ballast load at 120. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 5. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 7. Bypass Switch: Override the "on" function in case of sensor failure.
 8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.
- C. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.
1. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in..
 2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.
 3. Detection Coverage (Corridor): Detect occupancy within 90 feet when mounted on a 10-foot-high ceiling.
- D. Ultrasonic Type: Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy .
1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. when mounted on a 96-inch-high ceiling.
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.
 4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96-inch-high ceiling.
 5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet when mounted on a 10-foot-high ceiling in a corridor not wider than 14 feet.
- E. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.

3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

2.5 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

- 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. Bryant Electric; a Hubbell company.
2. Cooper Industries, Inc.
3. Hubbell Building Automation, Inc.
4. Leviton Mfg. Company Inc.
5. Lightolier Controls.
6. Lithonia Lighting; Acuity Lighting Group, Inc.
7. Lutron Electronics Co., Inc.
8. NSi Industries LLC; TORK Products.
9. RAB Lighting.
10. Sensor Switch, Inc.
11. Square D; a brand of Schneider Electric.
12. Watt Stopper.
13. Crestron.

- B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.

- C. Wall-Switch Sensor:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft..
2. Sensing Technology: PIR.
3. Switch Type: SP, field selectable automatic "on," or manual "on" automatic "off."
4. Voltage: Match the circuit voltage.
5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
7. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

2.6 EMERGENCY SHUNT RELAY

- 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. Lighting Control and Design: Acuity Lighting Group, Inc.
 - 2. Watt Stopper.
 - 3. Approved Equal
- B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.
 - 1. Coil Rating: 120 V.

2.7 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 22 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 16 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION

- A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

- A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Lighting control devices will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.7 DEMONSTRATION

- A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in Section 260943 "Centralized Relay-Based Dimming Lighting Controls."
- B. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 26 09 23

SECTION 26 09 43

CENTRALIZED NETWORKABLE LIGHTING CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Manually operated, PC-based, digital lighting controls with external signal source, relays with 0-10V dimming, and daylight harvesting.
 - 2. Manually operated, PC-based, addressable lighting controls with external signal source, and daylight harvesting.

1.3 DEFINITIONS

- A. DALI: Digital addressable lighting interface.
- B. Data Bus: Two wires used to communicate with bus connected devices.
- C. Device: A collective term for DALI-compliant bus connected devices, including fluorescent ballasts, incandescent luminaires, manual switches, switching relays, and similar. Sometimes also called "slave unit."
- D. Fade Rate: The time it takes each zone to arrive at the next scene, dependent on the degree of change in lighting level.
- E. Group: A set of devices that respond at the same time to messages on the data bus.
- F. IP: Internet protocol.
- G. Low Voltage: As defined in NFPA 70, the term for circuits and equipment operating at less than 50 V or for remote-control, signaling, and power-limited circuits.
- H. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
- I. RFI: Radio-frequency interference.

- J. Scene: The lighting effect created by adjusting several zones of lighting to the desired intensity.
- K. SCR: Silicon-controlled rectifier.
- L. Zone: A luminaire or group of luminaires controlled simultaneously as a single entity. Also known as a "channel."

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, relays, manual switches and plates, and conductors and cables.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Sound data including results of operational tests of central dimming controls.
4. Operational documentation for software and firmware.

B. Shop Drawings:

1. Floor Plans: Location, orientation, and coverage area of each sensor; group designations; and other specific design symbols and designations as required to define the installation, location, and configuration of all control devices.
2. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
3. Include diagrams for power, signal, and control wiring.
4. Detail enclosure types and details for types other than NEMA 250, Type 1.
5. Detail wiring partition configuration, current, and voltage ratings.
6. Short-circuit current rating of relays.
7. Address Drawing: Reflected ceiling plan and floor plans, showing data-bus-connected devices, address for each device, and device groups. The plans must be based on construction plans, using the same legend, symbols, and schedules.
8. Point List and Data Bus Load: Summary list of all control devices, sensors, ballasts, and other loads. Include percentage of rated connected load and device addresses.
9. Wire Termination Diagrams and Schedules: Coordinate nomenclature and presentation with Drawings and block diagram. Differentiate between manufacturer-installed and field-installed wiring.
10. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
11. Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in Section 23 09 00 "Instrumentation And Control For HVAC."

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
- B. Preinstallation Coordination Meeting(s): For digital-network lighting controls. Conduct meeting(s) as videoconference or at Project site before programming of controls.
 - 1. Attendees: Installers, fabricators, representatives of manufacturers, and administrators for field tests and inspections. Notify Architect, Construction Manager, and Owner's Commissioning Authority of scheduled meeting dates.
 - 2. Engage factory-authorized service representative to attend preinstallation conference and review the submittal drawing, sequence of operation, and device installation best practices with Project team.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Lighting control panel plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 - 1. Structural members in paths of lighting control panels.
 - 2. HVAC and plumbing items and architectural features in paths of lighting control panels.
- B. Field quality-control reports.
- C. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.
- D. Sample Warranty: For manufacturer's special warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.
- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On USB drive.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.
 - 5. Testing and adjusting of panic and emergency power features.

1.8 QUALITY ASSURANCE

- A. Source Limitations: Obtain lighting control module, power distribution components, peripherals and all accessories through one source from a single manufacturer.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with 47 CFR, Subparts A and B, for Class A digital devices.
- D. Comply with NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Handle and prepare panels for installation according to NECA 407.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Software: Failure of input and output to execute switching or dimming commands.
 - b. Damage from transient voltage surges.
 - c. Failure of software input/output to execute switching or dimming commands.
 - d. Damage of electronic components due to transient voltage surges.
 - 2. Warranty Period: Cost to repair or replace any parts for two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Sequence of Operations: Manual switches, an internal timing and control unit, and external sensors or other control signal sources send a signal to a PC-based network-system control module that processes the signal according to its programming and routes an open or close command to one or more relays in the power-supply circuits, or routes variable commands to one or more dimmers, for groups of lighting fixtures or other loads.
- B. Interface with BAS System: Hardware and software shall interface with BAS system to monitor, control, display, and record data for use in processing reports.
- C. Interface with Audio Video (AV) System: Hardware and software shall interface with AV system within the Courtrooms for monitoring, control, display, and record data for via AV system user interface.

- D. Expandability: System shall be capable of increasing the number of control functions in the future by 25 percent of current capacity; to include equipment ratings, housing capacities, spare relays, terminals, number of conductors in control cables, and control software.
- E. Compatibility:
 - 1. Dimming control components shall be compatible with luminaires.
- F. Dimmers and Dimmer Modules: Comply with UL 508.
 - 1. Audible Noise and RFI Suppression: Solid-state dimmers shall operate smoothly over their operating ranges without audible dimmer noise or RFI. Modules shall include integral or external filters to suppress audible noise and RFI.
 - 2. Dimmer or Dimmer-Module Rating: Not less than 125 percent of connected load unless otherwise indicated.
- G. Surge Protective Device: Factory installed as an integral part of control components or field-mounted surge suppressors complying with UL 1449, SPD Type 2.
- H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- I. Comply with 47 CFR 15, Subparts A and B, for Class A digital devices.
- J. Comply with UL 916.

2.2 NETWORKABLE DIMMABLE RELAY-BASED PANELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Acuity Controls.
 - 2. Crestron.
 - 3. Leviton.
 - 4. Lutron.
 - 5. Wattstopper.
- B. Description: Lighting dimming panels using mechanically latched relays to control lighting and appliances with 0-10V dimming for each zone. The panels shall be capable of being interconnected with digital communications to appear to the operator as a single lighting control system.
- C. Panels:
 - 1. A single enclosure with incoming lighting branch circuits, control circuits, switching relays, dimming modules, and on-board timing and control unit.
 - 2. A vertical barrier separating branch circuits from control wiring.

3. Vertical barrier(s) separating life safety and critical branch circuits from each other and all other circuits.
- D. Main Control Unit: Installed in the main lighting dimming panel only or in separate enclosure adjacent to main panel; powered from the branch circuit of the standard control unit.
1. Ethernet Communications: Comply with TCP/IP protocol. The main control unit shall provide for programming of all control functions of the main and all networked slave lighting dimming panels including timing, sequencing, and overriding.
 2. Web Server: Display information listed below over a standard Web-enabled server for displaying information over a standard browser.
 - a. A secure, password-protected login screen for modifying operational parameters, accessible to authorized users via Web page interface.
 - b. Panel summary showing the master and slave panels connected to the controller.
 - c. Controller diagnostic information.
 - d. Show front panel mimic screens for setting up controller parameters, input types, zones, and operating schedules. These mimic screens shall also allow direct breaker control and zone overrides.
 3. Timing Unit:
 - a. 365-day calendar, astronomical clock, and automatic adjustments for daylight savings and leap year.
 - b. Clock configurable for 12-hour (A.M./P.M.) or 24-hour format.
 - c. Four independent schedules, each having 24 time periods.
 - d. Schedule periods settable to the minute.
 - e. Day-of-week, day-of-month, day-of-year with one-time or repeating capability.
 - f. 16 special date periods.
 4. Time Synchronization: The timing unit shall be updated not less than every 24 hour(s) with the network time server.
 5. Sequencing Control with Override:
 - a. Automatic sequenced on and off switching of selected relays at times set at the timing unit, allowing timed overrides from external switches.
 - b. Sequencing control shall operate relays one at a time, completing the operation of all connected relays in not more than 10 seconds.
 - c. Override control shall allow any relay connected to it to be switched on or off by a field-deployed manual switch or by an automatic switch, such as an occupancy sensor.
 - d. Override control "blinking warning" shall warn occupants approximately five minutes before actuating the off sequence.
 - e. Activity log, storing previous relay operation, including the time and cause of the change of status.
 - f. Download firmware to the latest version offered by manufacturer.

- E. Standard Control Unit, Installed in All Lighting Panels: Contain electronic controls for the operation of the relays in the control panel, and contain communications link to enable the digital functions of the main control unit. Comply with UL 916.
 - 1. Electronic control for operating and monitoring individual relays, and display relay on-time.
 - 2. Nonvolatile memory shall retain all setup configurations. After a power failure, the controller shall automatically reboot and return to normal system operation.
- F. Relays: Electrically operated, mechanically held single-pole switch, rated at 20 A at 277 V. Short-circuit current rating shall be not less than 5 kA. Control shall be digital control network.
- G. Power Supply: NFPA 70, Class 2, UL listed, sized for connected equipment, plus not less than 25 percent spare capacity. Powered from a dedicated branch circuit of the panelboard that supplies power to the line side of the relays, sized to provide control power for the local panel-mounted relays, bus system, low-voltage inputs, field-installed occupancy sensors, and low-voltage photo sensors.
- H. Operator Interface: At the main control unit, provide interface for a tethered connection of a portable PC running MS Windows for configuring all networked lighting control panels using setup software designed for the specified operating system. Include one portable device for initial programming of the system and training of Owner's personnel. That device shall remain the property of Owner.
- I. Software:
 - 1. Menu-driven data entry.
 - 2. Online and offline programming and editing.
 - 3. Provide for entry of the room or space designation for the load side of each relay.
 - 4. Monitor and control all relays, showing actual relay state and the name of the automatic actuating control, if any.
 - 5. Size the software appropriate to the system.

2.3 WIRED NETWORKED DMX INTERFACE STATIONS:

- A. Manufacturers:
 - 1. nLight, Acuity Brands
 - 2. ETC.
 - 3. Lutron.
 - 4. Crestron.
 - 5. Or approved equal
- B. Description: Multi-protocol, bidirectional DMX512 playback (snapshot) and lighting control gateway.
 - 1. Capable of control of networked luminaire or all normal power lighting load types.
 - 2. Capable of control of DMX lighting through:

- a. DMX input for snapshot capture of lighting presets.
 - b. Live control of intensity, hue, and saturation of configured DMX Zones from connected stations.
 - c. Integral LED indicators for power, network traffic, processor health, identify, DMX port configuration and status.
 3. Support recall of up to 16 (total):
 - a. Prerecorded scenes/snapshots for playback.
 - b. DMX zones.
 4. Capable of preset playback as activated by any connected control station.
 5. Capable of DMX pass-through for real-time output of incoming DMX levels.
 6. Support four universes of ANSI E1.31 sACN-Streaming ACN (sACN), including priorities, for snapshot capture and recall.
 7. Support ANSI E1.20 RDM with PC-based software.
 8. Act as an ANSI E1.33 RDMnet controller.
- C. General Requirements:
1. Operating Voltages:
 - a. PoE Class 2 Device.
 - b. 24 V(dc) (not used if using PoE), 7 W maximum power consumption.
 2. Operating Temperature: Minus 32 to plus 113 deg F.
 3. DIN-Rail Mounted on DIN 43880 (35/7.5) rail.
 4. NEMA Type 1 enclosure.
- D. Features:
1. Lighting control ports supports:
 - a. Communication through lighting control (RJ-45) ports that supply 40 mA of power to each device via standard Category 5e low-voltage network cabling.
 - b. Detection of valid communication and blinking of a unique LED pattern to visually indicate a potential wiring issue.
 2. DMX Ports:
 - a. Comply with the requirements of ANSI E1.11 USITT DMX512-A standards.
 - b. Configurable as Input or Outputs.
 - c. Support ANSI E1.31 sACN.
 - d. Support Pathway Secure Streaming ACN (ssACN).
 - e. Comply with California Title 1.81.26.
 - f. Comply with ANSI E1.20 RDM.
 - g. Capable of withstanding fault voltages of up to 250 V(ac) without damage.
 - h. Dry contact closure input to connect with external control systems to control a lighting control zone or scene.

3. Ethernet Ports:

- a. Support IEEE 802.3af Power-over-Ethernet in absence of 24 V(dc).
- b. Support auto-negotiated 10/100MB connections speeds.
- c. Support IEEE 802.1AB Link Layer Discovery Protocol.
- d. Test Functions:
- e. Operate without need of a configuration PC to check local wiring.
- f. Test connectivity with DMX lights and networked luminaire or all normal power lighting load types.
- g. Complies with the following:
- h. RoHS 2011/65/EU + A1 2015/863.
- i. FCC.

2.4 REMOTE CONTROL STATIONS

A. Push-Button Switches: Modular, momentary contact, for operating one or more relays and to override automatic controls.

1. Engraved push buttons to select scenes.
2. Control Wiring: NFPA 70, Class 2.
3. Match color and style specified in Section 262726 "Wiring Devices."
4. Integral green LED pilot light to indicate when circuit is on.
5. Internal white LED locator light to illuminate when circuit is off.

B. Dimmers:

1. Regulate voltages to maintain a constant light level, with no visible flicker, when the source voltage varies plus or minus 2 percent of rms voltage.
2. Each zone shall be configurable to control the following loads:
 - a. LED lamps.
 - b. Non-dim, on-off switching only.

C. Touchscreen Controls:

1. Description: Backlit, color, LCD, touchscreen with 640 by 480 SVGA resolution with 16-bit color graphics. Capable of displaying high resolution media and text.
2. Wall-Station Screen Size: 5.7 inches.
3. Control Option: Software-defined controls for on-screen menu navigation.
4. Mounting Location: Wall
5. Coordinate faceplate color with Section 262726 "Wiring Devices."
6. Powerpack: 12-V dc.
7. Communications: Ethernet.

D. Tamper Resistant Push-Button Switches: Modular, momentary contact, for operating one or more relays.

1. Engraved push buttons to select scenes.
2. Control Wiring: NFPA 70, Class 2.

3. Construction: Tamper Resistant Stainless Steel, Intelligent Lighting Controls – WTS or approved equivalent.
- E. Memory: Retain preset scenes and fade settings through power failures by retaining physical settings of controls.
- F. Wall Plates: Single and multigang plates as specified in Section 262726 "Wiring Devices."
- G. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations provided by Architect during shop drawing review.

2.5 DAYLIGHT-HARVESTING DIMMING CONTROLS

- A. Manufacturers: Subject to compliance with requirements, provide products by one the following:
 1. Acuity Controls.
 2. Crestron.
 3. Leviton.
 4. Lutron.
 5. Wattstopper.
- B. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
 1. Lighting control set point is based on two lighting conditions:
 - a. When no daylight is present (target level).
 - b. When significant daylight is present.
 2. System programming is done with two hand-held, remote-control tools.
 - a. Initial setup tool.
 - b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.
- C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, to detect changes in lighting levels that are perceived by the eye.
- D. Electrical Components, Devices, and Accessories:
 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Sensor Output: 0- to 10-V dc to operate electronic dimming drivers.
 3. Light-Level Sensor Set-Point Adjustment Range: 5 to 100 fc.
 4. Controller unit: as specified in digital low voltage room controllers section of this specification.

2.6 OUTDOOR PHOTOELECTRIC SENSORS

- A. Description: Solid state, with digital interface to operate connected central dimming microprocessor input; complying with UL 773A.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Surge Protection: Metal-oxide varistor.
 - 3. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.
 - 4. Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.
 - 5. Test Mode: User selectable, overriding programmed time delay to allow settings check.
 - 6. Control Load Status: User selectable to confirm that load wiring is correct.
 - 7. Indicator: Two digital displays to indicate the beginning of on-off cycles.

2.7 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Twisted-Pair Data Cable: Category 6. Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store panels according to NECA 407.
- B. Examine panels before installation. Reject panels that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panels for compliance with installation tolerances and other conditions affecting performance of the Work.

- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Install cables in raceways except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
 - 1. Install plenum cable in environmental airspaces, including plenum ceilings.
 - 2. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- C. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 PANEL INSTALLATION

- A. Comply with NECA 1.
- B. Install panels and accessories according to NECA 407. Install filler plates in unused spaces.
- C. Mount top of trim 72 inches above finished floor unless otherwise indicated. Mount panel cabinet plumb and rigid without distortion of box.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."
- C. Create a directory to indicate loads served by each relay; incorporate Owner's final room designations. Obtain approval before installing. Use a PC or typewriter to create directory; handwritten directories are unacceptable.
- D. Lighting Panel Nameplates: Label each panel with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

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. Perform tests and inspections with the assistance of a factory-authorized service representative.
- C. Tests and Inspections:
 - 1. Test for circuit continuity.
 - 2. Verify that the control module features are operational.
 - 3. Check operation of local override controls
 - 4. Test system diagnostics by simulating improper operation of several components selected by Architect.
 - 5. Operational Test: Set and operate controls to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.
 - a. Include testing of dimming control equipment under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.
 - 6. Emergency Power Transfer: Test listed functions
 - 7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- D. Lighting panel will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies lighting control panels 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 or Delaware State approved lighting integrator to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Confirm correct communications wiring, initiate communications between panels, and program the lighting control system according to approved configuration schedules, time-of-day schedules, and input override assignments.
 - 3. Confirm correct communications wiring, initiate communications between DALI devices and controller/gateways, and program the lighting control system according to approved configuration schedules, time-of-day schedules, and input override assignments.

- B. Factory-authorized service representative or Delaware State approved lighting integrator shall provide pre-programmed seasonal color schemes in coordination with DFM requirements based on specific dates and required colors. As a supplement to this schedule, DFM grants service representative or lighting integrator creative license to suggest animation, color changes, fading, etc. to capitalize on the system's capabilities. Minimum of 16 pre-programmed scenes shall be included.

3.7 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 - 1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the control unit and operator interface.

END OF SECTION 26 09 43

SECTION 26 22 00

LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
 - 1. Distribution transformers.
 - 2. Class 2 control power transformers.

1.3 ACTION SUBMITTALS

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Source quality-control test reports.
- B. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain each transformer type through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.8 COORDINATION

- A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Products.
 - 2. General Electric Company.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; Schneider Electric.
 - 5. Functional Devices, Inc.

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices except for taps.
 - 1. Internal Coil Connections: Brazed or pressure type.
 - 2. Coil Material: Copper.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Cores: One leg per phase.
- C. Enclosure: Ventilated, NEMA 250, Type 2.
 - 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- D. Transformer Enclosure Finish: Comply with NEMA 250.
 - 1. Finish Color: Gray.
- E. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- F. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- G. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- H. Energy Efficiency for Transformers Rated 15 kVA and Larger:
 - 1. Complying with U.S. Department of Energy (DOE) 2016 Energy Efficiency Standards.
- I. Wall Brackets: Manufacturer's standard brackets.
- J. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.4 CLASS 2 CONTROL POWER TRANSFORMERS

- A. Comply with NEMA ST 1, and list and label as complying with UL 5085.
- B. Transformer voltages shall be 120V primary, 24V secondary.
- C. Transformer shall incorporate one primary and multiple 100VA secondary windings for a total capacity of 500VA.

- D. Enclosure for transformer shall be NEMA 1, non-ventilated, plenum-rated, galvanized steel.
- E. Transformer overcurrent protection shall be primary fuse (or inherently protected by internal impedance), and low voltage circuit breakers with terminal blocks and indicator LED's for each output winding.
- F. Transformer shall be UL 508 Approved, Class 2, manufactured by Functional Devices, Inc., model PSH500A-IC, or approved equivalent.

2.5 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

2.6 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.91.
- B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

1. Brace wall-mounting transformers as specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

3.3 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- C. Remove and replace units that do not pass tests or inspections and retest as specified above.
- D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.
- C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

516 N. KING ST, WILMINGTON DE 19801
#MJ0217000003-BP4

CUSTOM HOUSE RENOVATION AND ADDITION
NOVEMBER 22, 2024

END OF SECTION 26 22 00

LOW-VOLTAGE TRANSFORMERS
26 22 00 - 6

NOT FOR BID

WSP
TA PROJECT NO. 13670.00

SECTION 26 23 00

LOW-VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Low voltage switchgear purchased under separate Prepurchase package. Contractor responsible for installation.

1.3 DEFINITIONS

- A. ATS: Acceptance Testing Specifications.
- B. BIL: Basic Impulse Insulation Level.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around the low-voltage switchgear where pipe and ducts are prohibited.
- B. Product Test Reports: Submit evidence that switchgear is compatible with connected monitoring and control devices and systems specified in
 - 1. Show interconnecting signal and control wiring, and interface devices to show compatibility of meters.
 - 2. For reporting and billing interfaces and adapters, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of the protocol.
- C. Source quality-control reports.
- D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For equipment to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
 - a. Time-current curves (on full-size logarithmic paper) of the main secondary breaker and largest secondary feeder device.
 - b. Lists of spare parts and replacement components recommended for storage at Project site.
 - c. Detailed instructions covering operation under both normal and abnormal conditions.
 - d. Hard copies of manufacturer's operating specifications, user's guides for software and hardware, and PDF files on a USB storage device of hard-copy Submittal.
- B. "As-Built" wiring diagrams.
- C. Certified factory testing, field testing, and start-up commissioning reports.
- D. Complete, tabular list with table of contents of all device settings (overcurrent devices, control devices, auxiliary and communications devices, etc.) "as left" following field testing and start-up commissioning.
- E. Complete PLC and other programmable device program – printed hard copy and program CD.

1.6 FIELD CONDITIONS

- A. Ambient Environment Ratings:
 - 1. Ambient Temperature Rating: Not less than minus 22 deg F and not exceeding 104 deg F.
 - 2. Humidity Rating: Less than 95 percent (noncondensing).
 - 3. Altitude Rating: Not exceeding 6600 feet.

1.7 COORDINATION

- A. Coordinate layout and installation of switchgear with other construction that penetrates floors and ceilings, or is supported by them, including light fixtures, HVAC equipment, and fire-suppression-system components.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- C. Coordinate installation of underground conduit stubs ups with final switchgear location and concrete base.

PART 2 - PRODUCTS

2.1 PREPURCHASE PACKAGE

- A. Low voltage switchgear purchased under separate Prepurchase package.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install switchgear on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."
- B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.2 CONNECTIONS

- A. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- B. Terminate all grounding and bonding conductors on a common equipment grounding terminal on the switchgear enclosure. Install supplemental terminal bars, lugs, and bonding jumpers as required to accommodate the number of conductors for termination.
- C. Complete switchgear grounding and surge-protector connections prior to making any other electrical connections.

3.3 IDENTIFICATION

- A. Comply with the installation requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."
- B. Install warning signs as required to comply with OSHA 29 CFR 1910.269.

3.4 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Comply with provisions of NFPA 70B, "Testing and Test Methods" Chapter and of NETA ATS.
 - 2. After installing switchgear and after electrical circuitry has been energized, test for compliance with requirements.

3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
4. Visual and Mechanical Inspection:
 - a. Verify that fuse and circuit-breaker sizes and types correspond to Drawings and coordination study.
 - b. Verify that current and voltage transformer ratios correspond to Drawings.
 - c. Inspect bolted electrical connections for high resistance using one of the following two methods:
 - 1) Use a low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
 - d. Confirm correct operation and sequencing of electrical and mechanical interlock systems.
 - 1) Attempt closure on locked-open devices. Attempt to open locked-closed devices.
 - 2) Make key exchange with devices operated in off-normal positions.
 - e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
 - f. Inspect insulators for evidence of physical damage or contaminated surfaces.
 - g. Verify correct barrier and shutter installation and operation.
 - h. Exercise active components.
 - i. Inspect mechanical indicating devices for correct operation.
 - j. Verify that filters are in place and that vents are clear.
 - k. Perform visual and mechanical inspection of instrument transformers according to "Instrument Transformer Field Tests" Paragraph.
 - l. Inspect control power transformers.
 - 1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
 - 2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
 - 3) Verify correct functioning of drawout disconnecting and grounding contacts and interlocks.
5. Electrical Tests:
 - a. Perform dc voltage insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground, for one minute. If the bus temperature is

other than plus or minus 20 deg C, adjust the resulting resistance as provided in NETA ATS, Table 100.11.

- 1) Insulation-resistance values of bus insulation shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's written instructions or NETA ATS, Table 100.1.
 - 2) Do not proceed to the dielectric withstand voltage tests until insulation-resistance levels are raised above minimum values.
- b. Perform a dielectric withstand voltage test on each bus section, phase-to-ground with phases not under test grounded, according to manufacturer's published data. If manufacturer has no recommendation for this test, it shall be conducted according to NETA ATS, Table 100.2. Apply the test voltage for one minute.
- 1) If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.
- c. Perform insulation-resistance tests on control wiring for ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid-state components or control devices that cannot tolerate the applied voltage, follow the manufacturer's written instruction.
- 1) Minimum insulation-resistance values of control wiring shall not be less than 2 megohms.
- d. Control Power Transformers:
- 1) Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground. Insulation-resistance values of winding insulation shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's written instructions or NETA ATS, Table 100.1.
 - 2) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to a rated secondary voltage source. Verify correct potential at all devices.
 - 3) Verify correct secondary voltage by energizing the primary winding with system voltage. Measure secondary voltage with the secondary wiring disconnected.
 - 4) Verify correct function of control transfer relays located in the switchgear with multiple control power sources.
- e. Voltage Transformers:

- 1) Perform secondary wiring integrity test. Verify correct potential at all devices.
 - 2) Verify secondary voltages by energizing the primary winding with system voltage.
- f. Perform current-injection tests on the entire current circuit in each section of switchgear.
- 1) Perform current tests by secondary injection with magnitudes such that a minimum 1.0-A current flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.
- g. Perform system function tests according to "System Function Tests" Article.

B. Circuit-Breaker Field Tests:

1. Visual and Mechanical Inspection:

- a. Inspect physical and mechanical condition.
- b. Inspect anchorage, alignment, and grounding.
- c. Verify that all maintenance devices are available for servicing and operating the breaker.
- d. Verify the unit is clean.
- e. Verify that the arc chutes are intact.
- f. Inspect moving and stationary contacts for condition and alignment.
- g. Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.
- h. Perform mechanical operator and contact alignment tests on both the breaker and its operating mechanism according to manufacturer's published data.
- i. Verify cell fit and element alignment.
- j. Verify racking mechanism operation.
- k. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
- l. Perform adjustments for final protective-device settings according to coordination study provided by Owner.
- m. Record as-found and as-left operation counter readings.

2. Electrical Tests:

- a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with switch closed, and across each open pole. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.1. Insulation-resistance values shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Values of insulation resistance less than Table 100.1 or manufacturer's written instructions shall be investigated.
- b. Measure contact resistance across each power contact of the circuit breaker. Microhm or dc millivolt drop values shall not exceed the high

levels of the normal range as indicated in manufacturer's published data. In the absence of manufacturer's published data, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

- c. Determine long-time pickup and delay by primary current injection. Long-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors. If manufacturer's curves are unavailable, trip times shall not exceed the value shown in NETA ATS, Table 100.7.
- d. Determine short-time pickup and delay by primary current injection. Short-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
- e. Determine ground-fault pickup and delay by primary current injection. Ground-fault pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
- f. Determine instantaneous pickup value by primary current injection. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.8.
- g. Test functions of the trip unit by means of secondary injection. Pickup values and trip characteristic shall be as specified and within manufacturer's published tolerances.
- h. Perform minimum pickup voltage tests on shunt trip and close coils according to manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall comply with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.20.
- i. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
- j. Verify correct operation of any auxiliary features, such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free operation, antipump function, and trip-unit battery condition. Reset trip logs and indicators. Auxiliary features shall operate according to manufacturer's published data.
- k. Verify operation of charging mechanism. Charging mechanism shall operate according to manufacturer's published data.

C. Instrument Transformer Field Tests:

1. Visual and Mechanical Inspection:

- a. Verify that equipment nameplate data complies with the Contract Documents.
- b. Inspect physical and mechanical condition.
- c. Verify correct connection of transformers with system requirements.
- d. Verify that adequate clearances exist between primary and secondary circuit wiring.
- e. Verify that the unit is clean.
- f. Inspect bolted electrical connections for high resistance using one of the following two methods:

- 1) Use a low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
 - g. Verify that required grounding and shorting connections provide contact.
 - h. Verify correct operation of transformer withdrawal mechanism and grounding operation.
 - i. Verify correct primary and secondary fuse sizes for voltage transformers.
 - j. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
2. Electrical Tests of Current Transformers:
- a. Perform insulation-resistance test of each current transformer and its secondary wiring for ground at 1000-V dc for one minute. For units with solid-state components that cannot tolerate the applied voltage, follow manufacturer's written instructions. Investigate and correct values of insulation resistance less than manufacturer's written instructions or NETA ATS, Table 100.5.
 - b. Perform a polarity test of each current transformer according to IEEE C57.13.1. Polarity results shall agree with transformer markings.
 - c. Perform an excitation test on transformers used for relaying applications according to IEEE C57.13.1. Excitation results shall match the curve supplied by manufacturer or be according to IEEE C57.13.1.
 - d. Measure current circuit burdens at transformer terminals according to IEEE C57.13.1. Measured burdens shall be compared to, and shall match, instrument transformer ratings.
 - e. Perform power-factor or dissipation-factor tests according to test equipment manufacturer's published data.
 - f. Verify that current transformer secondary circuits are grounded and have only one grounding point according to IEEE C57.13.3. That grounding point should be located as specified by Engineer in Project Drawings.
3. Electrical Tests of Voltage Transformers:
- a. Perform insulation-resistance tests, winding-to-winding and winding-to-ground. Test voltages shall be applied for one minute according to NETA ATS Table 100.5. For units with solid-state components that cannot tolerate the applied voltage, follow manufacturer's written instructions. Investigate and correct values of insulation resistance less than manufacturer's written instructions or NETA ATS, Table 100.5.
 - b. Perform a polarity test on each transformer to verify the polarity marks or H1-X1 relationship as applicable. Polarity results shall agree with transformer markings.

- c. Measure voltage circuit burdens at transformer terminals. Measured burdens shall be compared to, and shall match, instrument transformer ratings.
- d. Perform a dielectric withstand test on the primary windings with the secondary windings connected to ground. Dielectric voltage shall be according to NETA ATS, Table 100.9. Test voltage shall be applied for one minute. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the primary windings are considered to have passed the test.
- e. Perform power-factor or dissipation-factor tests according to test equipment manufacturer's published data. Power-factor or dissipation-factor values shall be according to manufacturer's published data. In the absence of manufacturer's published data, use test equipment manufacturer's published data.
- f. Verify that voltage transformer secondary circuits are grounded and have only one grounding point according to IEEE C57.13.3. Test results shall indicate that the circuits are grounded at only one point.

D. Ground-Resistance Test:

1. Visual and Mechanical Inspection:

- a. Verify that ground system complies with the Contract Documents and with NFPA 70, Article 250, "Grounding and Bonding."
- b. Inspect physical and mechanical condition. Grounding system electrical and mechanical connections shall be free of corrosion.
- c. Inspect bolted electrical connections for high resistance using one of the following two methods:
 - 1) Use a low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
- d. Inspect anchorage.

2. Electrical Tests:

- a. Perform fall-of-potential or alternative test according to IEEE 81 on the main grounding electrode or system. Resistance between the main grounding electrode and ground shall be no more than 5 ohms.
- b. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and derived neutral points. Investigate point-to-point resistance values that exceed 0.5 ohms. Compare equipment nameplate data with the Contract Documents.

- c. Inspect physical and mechanical condition.
- d. Inspect bolted electrical connections for high resistance using one of the following two methods:
 - 1) Use a low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.

E. Metering Devices Field Tests:

1. Visual and Mechanical Inspection:

- a. Inspect physical and mechanical condition.
- b. Inspect bolted electrical connections for high resistance using one of the following two methods:
 - 1) Use a low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
- c. Inspect cover gasket, cover glass, condition of spiral spring, disk clearance, contacts, and case shorting contacts, as applicable.
- d. Verify that the unit is clean.
- e. Verify freedom of movement, end play, and alignment of rotating disk(s).

2. Electrical Tests:

- a. Verify accuracy of meters at all cardinal points. Meter accuracy shall be according to manufacturer's published data.
- b. Calibrate meters according to manufacturer's published data. Calibration results shall be within manufacturer's published tolerances.
- c. Verify all instrument multipliers. Instrument multipliers shall be according to system design specifications.
- d. Verify that current transformer and voltage transformer secondary circuits are intact. Test results shall confirm the integrity of the secondary circuits of current and voltage transformers.

F. Microprocessor-Based Protective Relay Field Tests:

1. Visual and Mechanical Inspection:

- a. Record model number, style number, serial number, firmware revision, software revision, and rated control voltage.
- b. Verify operation of LEDs, display, and targets.
- c. Record passwords for each access level.
- d. Clean the front panel and remove foreign material from the case.
- e. Check tightness of connections.
- f. Verify that the frame is grounded according to manufacturer's written instructions.
- g. Set the relay according to results in Section 260573.16 "Coordination Studies" and in Section 260573.19 "Arc-Flash Hazard Analysis."
- h. Download settings from the relay. Print a copy of the settings for the report and compare the settings to those specified in the coordination study.

2. Electrical Tests:

- a. Perform insulation-resistance tests from each circuit to the grounded frame according to manufacturer's published data.
- b. Apply voltage or current to analog inputs, and verify correct registration of the relay meter functions.
- c. Check functional operation of each element used in the protection scheme as follows:

1) ANSI No. 2/62, Timing Relay:

- a) Determine time delay.
- b) Verify operation of instantaneous contacts.

2) ANSI No. 24, Volts/Hertz Relay:

- a) Determine pickup frequency at rated voltage.
- b) Determine pickup frequency at a second voltage level.
- c) Determine time delay.

3) ANSI No. 25, Sync Check Relay:

- a) Determine closing zone at rated voltage.
- b) Determine maximum voltage differential that permits closing at zero degrees.
- c) Determine set points of live line, live bus, dead line, and dead bus.
- d) Determine time delay.
- e) Verify control functions of dead bus/live line, dead line/live bus, and dead bus/dead line.

4) ANSI No. 27, Undervoltage Relay:

- a) Determine dropout voltage.
- b) Determine time delay.

- c) Determine time delay at a second point on the timing curve for inverse time relays.
- 5) ANSI No. 32, Directional Power Relay:
 - a) Determine minimum pickup at maximum torque angle.
 - b) Determine closing zone.
 - c) Determine maximum torque angle.
 - d) Determine time delay.
 - e) Verify time delay at a second point on the timing curve for inverse time relays.
- 6) ANSI No. 46, Current Balance Relay:
 - a) Determine pickup of each unit.
 - b) Determine percent slope.
 - c) Determine time delay.
- 7) ANSI No. 46N, Negative Sequence Current Relay:
 - a) Determine negative sequence alarm level.
 - b) Determine negative sequence minimum trip level.
 - c) Determine maximum time delay.
 - d) Verify two points on the I-two-squared-T curve.
- 8) ANSI No. 47, Phase Sequence or Phase Balance Voltage Relay:
 - a) Determine positive sequence voltage to close the NO contact.
 - b) Determine positive sequence voltage to open the NC contact (undervoltage trip).
 - c) Verify negative sequence trip.
 - d) Determine time delay to close the NO contact with sudden application of 120 percent of pickup.
 - e) Determine time delay to close the NC contact on removal of voltage when previously set to rated system voltage.
- 9) ANSI No. 50, Instantaneous Overcurrent Relay:
 - a) Determine pickup.
 - b) Determine dropout.
- 10) ANSI No. 51, Time Overcurrent:
 - a) Determine minimum pickup.
 - b) Determine time delay at two points on the time current curve.
- 11) ANSI No. 64, Ground Detector Relay:
 - a) Determine maximum impedance to ground causing relay pickup.

12) ANSI No. 67, Directional Overcurrent Relay:

- a) Determine directional unit minimum pickup at maximum torque angle.
- b) Determine closing zone.
- c) Determine overcurrent unit pickup.
- d) Determine overcurrent unit time delay at two points on the time current curve.

d. Control Verification:

1) Functional Tests:

- a) Check operation of all active digital inputs.
- b) Check output contacts or SCRs, preferably by operating the controlled device, such as circuit breaker, auxiliary relay, or alarm.
- c) Check internal logic functions used in protection scheme.
- d) On completion of testing, reset minimum/maximum recorders, communications statistics, fault counters, sequence-of-events recorder, and event records.

2) In-Service Monitoring: After the equipment is initially energized, measure magnitude and phase angle of inputs and verify expected values.

G. Ground-Fault Protection Field Tests: Evaluate the interconnected system according to switchgear manufacturer's written instructions.

- 1. Determine the proper location of the sensors around the bus of the circuit to be protected. This determination may be done visually, with knowledge of which bus is involved.
- 2. Verify the grounding points of the system to determine that ground paths do not exist that would bypass the sensors. Use high-voltage testers and resistance bridges.
- 3. Test the installed system for correct response by application of full-scale current into the equipment to duplicate a ground-fault condition, or by equivalent means such as by simulated fault current generated by the following:
 - a. A coil around the sensors.
 - b. A separate test winding in the sensors.
- 4. Record the test results on the test form provided with the instructions provided by manufacturer.

H. Switchgear components will be considered defective if they do not pass tests and inspections.

I. Remove and replace defective units and retest.

J. Prepare test and inspection reports. Record as-left set points of adjustable devices.

3.5 SYSTEM FUNCTION TESTS

- A. System function tests shall prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality-control tests have been completed and all components have passed specified tests.
 - 1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
 - 2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
 - 3. Verify the correct operation of sensing devices, alarms, and indicating devices.
- B. Switchgear will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.6 FOLLOW-UP SERVICE

- A. Voltage Monitoring and Adjusting: After Substantial Completion, but not more than six months after Final Acceptance, and if requested by Owner, perform the following voltage monitoring:
 - 1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the outgoing section of each piece of switchgear. Use voltmeters with calibration traceable to NIST standards and with a chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.
 - 2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:
 - a. Adjust switchgear taps.
 - b. Prepare written request for voltage adjustment by electric utility.
 - 3. Retests: Repeat monitoring, after corrective action has been performed, until specified results are obtained.
 - 4. Report:
 - a. Prepare a written report covering monitoring performed and corrective action taken.
- B. Infrared Inspection: Perform the survey during periods of maximum possible loading. Remove covers prior to inspection.
 - 1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of switchgear.
 - 2. Instrument: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 30 deg C.

3. Record of Infrared Inspection: Prepare a certified report that identifies the testing technician and equipment used and that lists the results as follows:
 - a. Description of equipment to be tested.
 - b. Discrepancies.
 - c. Temperature difference between the area of concern and the reference area.
 - d. Probable cause of temperature difference.
 - e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
 - f. Identify load conditions at time of inspection.
 - g. Provide photographs and thermograms of the deficient area.
4. Act on inspection results according to recommendations in NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

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SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

- A. SVR: Suppressed voltage rating.
- B. SPD: Surge Protective Device.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 6. Include wiring diagrams for power, signal, and control wiring.
 - 7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards.

1.5 INFORMATIONAL SUBMITTALS

- A. Field Quality-Control Reports:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- B. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 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. Keys: Two spares for each type of panelboard cabinet lock.
 - 2. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 3. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.8 QUALITY ASSURANCE

- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer. (Exception: Fused panelboards and fuses may be obtained from a different manufacturer than circuit breaker panelboards.)
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NECA 407.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 23°F to plus 104°F.
 - b. Altitude: Not exceeding 6600 feet.
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet.

1.11 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.12 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Enclosures: Flush- and surface-mounted cabinets.
 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1
 - b. Other Wet or Damp Indoor Locations: NEMA 250 Type 4X stainless steel.
 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 3. Hinged Front Cover: Entire front trim hinged to box with full length stainless steel piano hinge, and with standard door within hinged trim cover. "EZ Trim" covers are not acceptable.
 4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
 5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
 6. Finishes:
 - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel, or same finish as panels and trim where required for environmental conditions.
 - c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
 7. Directory Card: Inside panelboard door, mounted in transparent card holder.
- B. Incoming Mains Location: Top or bottom, contractor to coordinate with drawings and installation requirements.
- C. Phase, Neutral, and Ground Buses:
 1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
 4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
- D. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Main and Neutral Lugs: Mechanical type.
 3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
 4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 6. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.
- F. Future Devices (Spaces, provisions for future): Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

- A. Applicability: "Distribution Panelboards" are defined as panelboards greater than 26" wide by 6" deep, main bus capacity of 400 amperes or more, regardless of naming or application. For smaller panelboards, refer to "Lighting and Appliance Branch-Circuit Panelboards" below.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
 5. Cooper Bussmann, division of Cooper Industries.
 6. Littelfuse, Inc.
 7. Mersen.
- C. Panelboards: NEMA PB 1, power and feeder distribution type.
- D. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
1. For doors more than 36" high, provide two latches, keyed alike.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers, thermal-magnetic tripping.

- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Electronic trip, Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- G. Branch Overcurrent Protective Devices (for panels indicated to be fused type on the drawings only): Fused switches.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
 - 5. Cooper Bussmann, division of Cooper Industries.
 - 6. Littelfuse, Inc.
 - 7. Mersen.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Branch Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers, replaceable without disturbing adjacent units. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
 - 5. Cooper Bussmann, division of Cooper Industries.
 - 6. Littelfuse, Inc.
 - 7. Mersen.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents. Devices and assemblies shall be fully rated; series rating is not permitted.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 225 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

3. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator. For 4-wire load feeders, provide corresponding neutral conductor current sensor.
 - e. Shunt Trip: 120V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
 - f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional with field-adjustable 0.1- to 0.6-second time delay.
 - g. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
 - h. Handle Padlocking Device: Compliant with National Electrical Code Article 110.25, fixed attachment, for locking circuit-breaker handle in off position. Attachment shall not be removable when padlock is removed.
 - i. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
- 1) Where required by applicable codes, circuit breakers serving emergency lighting branch circuits, fire alarm equipment, fire protection equipment, and similar shall be equipped with handle clamps.

2.5 PANELBOARD SURGE PROTECTIVE DEVICES

- 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. Current Technology; a subsidiary of Danahar Corporation.
 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 4. Liebert Corporation.
 5. Siemens Energy & Automation, Inc.
 6. Square D; a brand of Schneider Electric.
- B. Surge Protective Devices shall be furnished in panelboards where required by National Electrical Code Article 700 for emergency power system panelboards,.
- C. Surge Protective Device: IEEE C62.41-compliant, integrally mounted, plug-in, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, UL 1449, fourth edition, short-circuit

current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:

1. Accessories:
 - a. Fuses rated at 200-kA interrupting capacity.
 - b. Fabrication using bolted compression lugs for internal wiring.
 - c. Integral disconnect switch.
 - d. Redundant suppression circuits.
 - e. Redundant replaceable modules.
 - f. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 - g. LED indicator lights for power and protection status.
 - h. Audible alarm, with silencing switch, to indicate when protection has failed.
 - i. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
 - j. Four-digit, transient-event counter set to totalize transient surges.
2. Peak Single-Impulse Surge Current Rating: 120 kA per mode/240 kA per phase.
3. Minimum single-impulse current ratings, using 8-by-20-mic.sec. waveform described in IEEE C62.41.2.
 - a. Line to Neutral: 70,000 A.
 - b. Line to Ground: 70,000 A.
 - c. Neutral to Ground: 50,000 A.
4. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.

2.6 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NECA 407.

- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install panelboards and accessories according to NECA 407.
- B. Equipment Mounting: Where drawings indicate free-standing locations, install panelboards on concrete bases, 4-inch nominal thickness, with structural steel supports.
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
 - 2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to panelboards.
 - 5. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- D. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- E. Mount top of trim 72 inches above finished floor unless otherwise indicated, or as required for taller equipment. In all cases, center of top-most circuit breaker or switch handle in the energized position shall not exceed 79 inches above finished floor or grade.
- F. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- G. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- H. Install filler plates in unused spaces.
- I. Stub four empty 1-inch conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

- J. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- K. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Where required by applicable codes, breakers for fire alarm, fire protection equipment, and similar shall be identified with a red handle and/or red nameplate.
- E. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each

panelboard. Remove front panels so joints and connections are accessible to portable scanner.

- b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
- c. Instruments and Equipment:

- 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

- 1. Measure as directed during period of normal system loading.
- 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
- 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
- 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 26 24 16

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CUSTOM HOUSE RENOVATION AND ADDITION
NOVEMBER 22, 2024

SECTION 26 25 50

DUAL PURPOSE GENERATOR DOCKING STATION

PART 1 - GENERAL

1.1 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 PREPURCHASE PACKAGE

- A. Dual Purpose Docking Station purchased under separate Prepurchase package.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive Generator Docking Station for compliance with installation tolerances and other conditions affecting performance of the Work.

3.2 INSTALLATION

- A. Surface, Flush or Base Mounted: Determined by Application
 - 1. Install anchor bolts to elevations required for proper attachment to Generator Docking Station.

3.3 FIELD QUALITY CONTROL

- A. Third Party Tests and Inspections to include the following:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- B. Prepare test and inspection reports, including a certified report that identifies Generator Docking Station and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262550

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SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Tamper-resistant receptacles.
4. Weather-resistant receptacles.
5. Snap switches and wall-box dimmers.
6. Wall-switch and exterior occupancy sensors.
7. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.

1.6 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Service/Power Poles: One for every 10, but no fewer than two.
 - 2. Floor Service-Outlet Assemblies: One for every 10, but no fewer than two.
 - 3. Poke-Through, Fire-Rated Closure Plugs: One for every 10, but no fewer than two.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 - 1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
 - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 - 3. Leviton Mfg. Company Inc. (Leviton).
 - 4. Pass & Seymour/Legrand (Pass & Seymour).
 - 5. Or approved equal
- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
 - 1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
 - 2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 5351 (single), CR5362 (duplex).
 - b. Hubbell; HBL5351 (single), HBL5352 (duplex).
 - c. Leviton; 5891 (single), 5352 (duplex).
 - d. Pass & Seymour; 5361 (single), 5362 (duplex).

2.4 GFCI RECEPTACLES

- A. General Description:
 - 1. Straight blade, feed-through type.
 - 2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
 - 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; VGF20.
 - b. Hubbell; GFR5352L.
 - c. Pass & Seymour; 2095.
 - d. Leviton; 7590.
- C. Tamper-Resistant GFCI Convenience Receptacles, 125 V, 20 A:
 - 1. Products: Subject to compliance with requirements, provide one of the following:

- a. Hubbell; GFTR20.
 - b. Pass & Seymour; 2095TR.
- D. Tamper- and Weather-Resistant, Duplex GFCI Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.
1. Products: Subject to compliance with requirements, provide one of the following:
- a. Cooper; WRS GF20.
 - b. Hubbell; GFR5362SG .
 - c. Leviton; G5362-WT.
 - d. Pass & Seymour; 2097TRWR.
- E. Double-duplex, or “Quad” receptacles: Provide two duplex receptacles in a common outlet. Double-duplex GFCI shall consist of two duplex GFCI receptacles.

2.5 TWIST-LOCKING RECEPTACLES

- A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
- a. Cooper; CWL520R.
 - b. Hubbell; HBL2310.
 - c. Leviton; 2310.
 - d. Pass & Seymour; L520-R.
2. Description:
- a. Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.
 - b. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.
- B. Single Convenience Receptacles, 250 V, 30 A: Comply with NEMA WD 1, NEMA WD 6 Configuration L6-30R, and UL 498.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
- a. Cooper; CWL630R.
 - b. Hubbell; HBL2620.
 - c. Leviton; 2620.
 - d. Pass & Seymour; L630-R.

2. Description:

- a. Comply with NEMA WD 1, NEMA WD 6 Configuration L6-30R, and UL 498.
- b. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.6 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896. Nylon body and toggle, heavy duty, chemical resistant.

B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Single Pole:

- 1) Cooper; AH1221.
- 2) Hubbell; HBL1221.
- 3) Leviton; 1221-2.

b. Two Pole:

- 1) Cooper; AH1222.
- 2) Hubbell; HBL1222.
- 3) Leviton; 1222-2.

c. Three Way:

- 1) Cooper; AH1223.
- 2) Hubbell; HBL1223.
- 3) Leviton; 1223-2.

d. Four Way:

- 1) Cooper; AH1224.
- 2) Hubbell; HBL1224.
- 3) Leviton; 1224-2.

C. Pilot-Light Switches, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Cooper; AH1221PL for 120 and 277 V.
- b. Hubbell; HBL1201PL for 120 and 277 V.
- c. Leviton; 1221-LH1.

2. Description: Single pole, with neon-lighted handle, illuminated when switch is "off."

D. Key-Operated Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; AH1221L.
 - b. Hubbell; HBL1221L.
 - c. Leviton; 1221-2L.

2. Description: Single pole, with factory-supplied key in lieu of switch handle.

E. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with low voltage lighting relay.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 1995.
 - b. Hubbell; HBL1557.
 - c. Leviton; 1257.

2.7 WALL-BOX DIMMERS

- A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters, compatible with décora faceplate.
1. Products:
 - a. Illumatech IP710 series.
 - b. Approved equal
- B. Control: Continuously adjustable slider, with single-pole or three-way switching. Comply with UL 1472.

2.8 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
1. Plate-Securing Screws: Metal with head color to match plate finish.
 2. Material for Finished and Unfinished Spaces, recessed mount: 0.035-inch- thick, satin-finished, Type 302 stainless steel.
 3. Material for Unfinished Spaces, surface mount: Galvanized steel raised device cover.
 4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant in use, die-cast aluminum extra duty type, with lockable cover.

2.9 FLOOR SERVICE FITTINGS

- A. Type: Modular, flush-type, dual-service units suitable for wiring method used.
- B. Compartments: Barrier separates power from voice and data communication cabling.
- C. Service Plate: Round, die-cast aluminum with satin finish.
- D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.

2.10 POKE-THROUGH ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Incorporated; Wiring Device-Kellems.
 - 2. Pass & Seymour/Legrand.
 - 3. Square D/Schneider Electric.
 - 4. Thomas & Betts Corporation.
 - 5. Wiremold/Legrand.
- B. Description:
 - 1. Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.
 - 2. Comply with UL 514 scrub water exclusion requirements.
 - 3. Service-Outlet Assembly: Flush type with four simplex receptacles and space for four RJ-45 jacks complying with requirements in Section 27 15 00 "Communications Horizontal Cabling."
 - 4. Size: Selected to fit nominal 6-inch cored holes in floor and matched to floor thickness.
 - 5. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
 - 6. Closure Plug: Arranged to close unused 6-inch cored openings and reestablish fire rating of floor.
 - 7. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of four, four-pair cables that comply with requirements in Section 27 15 00 "Communications Horizontal Cabling."

2.11 TABLE BOXES

- A. Manufacturers:
 - 1. Basis-of-Design Product: The design for table boxes, fittings, cable retractors, under table cable management kits, and transition channels is based on Extron Cable Cubby Series 1201
 - 2. Or approved equal
- B. Description

1. Classification and Use: Table boxes shall be cETLus listed furniture power distribution units.
2. Table Boxes shall provide convenience outlets for power, data and A/V services.
3. Table Boxes are designed to fit together with other products by same manufacturer providing cable protection and organization.
4. Cover: Brushed, anodized aluminum cover in a black finish with beveled edges and "soft-touch" handle.
5. Cover contains a "pocket" door which fully recesses into the box when open, giving access to connections without obstructing work surface. A finishing plate hides hardware on activation surface and permits labeling of the AVIP plates.
6. Activation Surface: Adjustable downward in 1/2-inch [12.7mm] increments, from one (1) inch to four (4) inches [25mm to 102mm] to allow cover to close even when large style connectors are used.
7. Provide table boxes with a 12 foot SJT cord for easy connection to electrical infrastructure.
8. Supply tables boxes with a cable grommet kit that can accommodate up to four (4) pull out connections.
9. Provide table boxes with two (2) 15 amp receptacles and (2) USB-A connections in top compartment

C. CABLE RETRACTORS

1. Cable Retractors mount directly to table Box or underside of table using a horizontal mounting bracket.
2. Loaded with 5 feet of corresponding data or AV cable. Supply retractor with a female input from building infrastructure and a male connector on the output side.
3. Cable Retractor Horizontal Mounting Brackets: Permits retractor to mount horizontally under conference room table, enabling cable access through a table grommet. Multiple retractors can be mounted to each other by attaching the mounting brackets to each other.

D. 2.4 UNDER TABLE CABLE MANAGEMENT KIT

1. Under Table Cable Management Kit under table cable management kit provides clean cable management for power, communication and A/V cables on horizontal underside of table.

2.12 PREFABRICATED MULTIOUTLET ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Hubbell Incorporated; Wiring Device-Kellems.
2. Wiremold/Legrand.
3. Or Approved Equal

- B. Description:

1. Two-piece surface metal raceway, with factory-wired multioutlet harness.

2. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

C. Raceway Material: Metal, with manufacturer's standard finish.

D. Multioutlet Harness:

1. Receptacles: 15-A, 125-V, NEMA WD 6 Configuration 5-15R receptacles complying with NEMA WD 1, UL 498, and FS W-C-596.
2. Receptacle Spacing: 6 inches (150 mm).
3. Wiring: No. 12 AWG solid, Type THHN copper, single circuit.

2.13 SERVICE POLES

A. Description:

1. Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.
2. Poles: Nominal 2.5-inch- square cross section, with height adequate to extend from floor to at least 6 inches above ceiling, and with separate channels for power wiring and voice and data communication cabling.
3. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
4. Finishes: Satin-anodized aluminum.
5. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, four-pair, Category 3 or Category 5 voice and data communication cables.
6. Power Receptacles: Two duplex, 20-A, straight-blade receptacles complying with requirements in this Section.

2.14 FINISHES

A. Device Color:

1. Wiring Devices Connected to Normal Power System: Ivory unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red.

B. Wall Plate Color: Contractor shall present all potential option and coordinate with owner and architect prior to purchase

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

- B. Strictly comply with manufacturer's installation instructions and recommendations. Coordinate installation with adjacent work to ensure proper clearances and to prevent electrical hazards.
- C. Coordination with Other Trades:
 - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.
- D. Conductors:
 - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 - 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailling existing conductors is permitted, provided the outlet box is large enough.
- E. Device Installation:
 - 1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
 - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
 - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
 - 6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
 - 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 - 8. Tighten unused terminal screws on the device.

9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

F. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.

G. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

H. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

I. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

J. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

- A. Comply with Section 260553 "Identification for Electrical Systems."
- B. Identify each receptacle with panelboard identification and circuit number. Use silk screened or engraved machine printing, with black filled lettering on face of plate, red for emergency circuits, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Test Instruments: Use instruments that comply with UL 1436.
 2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- B. Tests for Convenience Receptacles:
 1. Line Voltage: Acceptable range is 105 to 132 V.

2. Percent Voltage Drop under a 80%: A value of 6 percent or higher is unacceptable.
 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 4. Polarity: Verify correct polarity of all receptacle phase and neutral conductors is maintained.
 5. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 6. Using the test plug, verify that the device and its outlet box are securely mounted.
 7. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- C. Wiring device will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 26 27 26

SECTION 26 28 13

FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, and enclosed controllers.
2. Spare-fuse cabinets.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
5. Coordination charts and tables and related data.
6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.

3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
4. Coordination charts and tables and related data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.

1.7 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.8 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Cooper Bussmann, Inc.
 2. Edison Fuse, Inc.
 3. Ferraz Shawmut, Inc.
 4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.3 SPARE-FUSE CABINET

- A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
 - 1. Size: Adequate for storage of spare fuses specified with 20 percent spare capacity minimum.
 - 2. Finish: Gray, baked enamel.
 - 3. Identification: "SPARE FUSES" in 1-1/2-inch-high letters on exterior of door.
 - 4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Cartridge Fuses:
 - 1. Service Entrance: Class J, time delay.
 - 2. Feeders: Class J, time delay.
 - 3. Motor Branch Circuits: Class RK5, time delay.
 - 4. Other Branch Circuits: Class CC.
 - 5. Control Circuits: Class CC.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

- B. Install spare-fuse cabinet(s).

3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 28 13

SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Non-fusible switches.
 - 3. Elevator fused disconnect switch power module.
 - 4. Enclosed molded-case circuit breakers (MCCBs).
 - 5. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - 5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

- 1. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

- 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

- 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - 2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.7 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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Fuse Pullers: Two for each size and type.

1.8 QUALITY ASSURANCE

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- D. Comply with NFPA 70.

1.9 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 2. Altitude: Not exceeding 6600 feet.

1.10 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, 600V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: For switches applied on four wire branch circuits and feeders. Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 4. Auxiliary Contact Kit: Where required for application, such as installation on load side of variable frequency controller, elevator controller with emergency rundown feature, or other, provide One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.

5. Lugs: Mechanical or compression type, suitable for number, size, and conductor material.
6. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, 600V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 4. Auxiliary Contact Kit: Where required for application, such as installation on load side of variable frequency controller, elevator controller with emergency rundown feature, or other, provide One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
 5. Lugs: Mechanical or compression type, suitable for number, size, and conductor material.

2.3 ELEVATOR FUSED DISCONNECT SWITCH POWER MODEL

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Cooper Bussmann, Inc.
 2. Mersen, Inc..
 3. Littelfuse, Inc.
 4. Eaton Electrical, Inc., Cutler-Hammer Business Unit
- B. General Requirements: Comply with ASME A17.1, NFPA 72, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.
- C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

- D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power transformer of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.
- E. Accessories:
 - 1. Oiltight key switch for key-to-test function.
 - 2. Oiltight Red ON pilot light, push-to-test.
 - 3. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
 - 4. Form C alarm contacts that change state when switch is tripped.
 - 5. Three-pole, double-throw, fire-safety and alarm relay; 120 Vac coil voltage.
 - 6. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

2.4 ENCLOSED MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- E. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- F. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Lugs: Mechanical or Compression type, suitable for number, size, trip ratings, and conductor material.
 - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 - 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
7. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

2.5 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 2. Outdoor Locations: NEMA 250, Type 3R.
 3. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in fusible devices.
- D. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

516 N. KING ST, WILMINGTON DE 19801
#MJ0217000003-BP4

CUSTOM HOUSE RENOVATION AND ADDITION
NOVEMBER 22, 2024

END OF SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS
26 28 16 - 8

NOT FOR BID

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TA PROJECT NO. 13670.00

SECTION 26 29 13
ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes the following enclosed controllers rated 600 V and less:
 - 1. Full-voltage manual.
 - 2. Full-voltage magnetic.
 - 3. Reduced-voltage magnetic.
 - 4. Reduced-voltage solid state.
 - 5. Multispeed.
- B. Related Section:
 - 1. Section 262923 "Variable-Frequency Motor Controllers" for general-purpose, ac, adjustable-frequency, pulse-width-modulated controllers for use on variable torque loads in ranges up to 200 hp.

1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. N.C.: Normally closed.
- E. N.O.: Normally open.
- F. OCPD: Overcurrent protective device.
- G. SCR: Silicon-controlled rectifier.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.
- B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.
 - 1. Show tabulations of the following:
 - a. Each installed unit's type and details.
 - b. Factory-installed devices.
 - c. Nameplate legends.
 - d. Short-circuit current rating of integrated unit.
 - e. Listed and labeled for integrated short-circuit current (withstand) rating of OCPDs in combination controllers by an NRTL acceptable to authorities having jurisdiction.
 - f. Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.
 - 2. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. 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.
- C. 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 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
 - 1. Routine maintenance requirements for enclosed controllers and installed components.
 - 2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
 - 3. Manufacturer's written instructions for setting field-adjustable overload relays.
 - 4. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.

1.7 MATERIALS MAINTENANCE SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 - 3. Indicating Lights: Two of each type and color installed.
 - 4. Auxiliary Contacts: Furnish six spare(s) for each size and type of magnetic controller installed.
 - 5. Power Contacts: Furnish six spares for each size and type of magnetic contactor installed.

1.8 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 - 2. Altitude: Not exceeding 6600 feet.

1.11 COORDINATION

- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 FULL-VOLTAGE CONTROLLERS

- A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.
- B. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - c. Siemens Energy & Automation, Inc.
 - d. Square D; a brand of Schneider Electric.
 2. Configuration: Non-reversing, full voltage.
 3. Surface mounting.
 4. Red pilot light.
 5. Additional Nameplates: ON-OFF or RUN-STOP.
- C. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - c. Siemens Energy & Automation, Inc.
 - d. Square D; a brand of Schneider Electric.
 2. Configuration: Non-Reversing.
 3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
 4. Surface mounting.
 5. Red pilot light.
 6. Additional Nameplates: ON-OFF or RUN-STOP.
 7. Lockable Handle: Accepts a padlock and interlocks with cover in closed position.
 8. Motor switches shall be identical to manual motor starters, with overload protection omitted.

- D. Integral Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - c. Siemens Energy & Automation, Inc.
 - d. Square D; a brand of Schneider Electric.
 2. Configuration: Nonreversing.
 3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters and sensors in each phase, matched to nameplate full-load current of actual protected motor and having appropriate adjustment for duty cycle; external reset push button; bimetallic type.
 4. Surface mounting.
 5. Red pilot light.
 6. Additional Nameplates: ON-OFF or RUN-STOP.
 7. N.O. auxiliary contact.
- E. Magnetic Controllers: Full voltage, across the line, electrically held.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - c. Siemens Energy & Automation, Inc.
 - d. Square D; a brand of Schneider Electric.
 2. Configuration: Nonreversing.
 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.
 4. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
 5. Control Circuits: 120V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 6. Bimetallic Overload Relays:
 - a. Inverse-time-current characteristic.
 - b. Class 10 tripping characteristic.

- c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 - d. Ambient compensated.
- 7. External overload reset push button.
- F. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - c. Square D; a brand of Schneider Electric.
 - 2. Fusible Disconnecting Means:
 - a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class RK5 fuses.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - 3. Nonfusible Disconnecting Means:
 - a. NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - 4. MCP Disconnecting Means:
 - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - 5. MCCB Disconnecting Means:
 - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
 - b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

2.2 ENCLOSURES

- A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
 - 1. Dry and Clean Indoor Locations: Type 1
 - 2. Outdoor Locations: Type 3R.

2.3 ACCESSORIES

- A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
 - 1. Pilot Lights, and Selector Switches: Heavy duty, oiltight type.
 - a. Pilot Lights: LED types; red "On", green "Off"; push to test
 - b. Selector Switches: Rotary type "Hand – Off – Automatic"
- B. Two sets N.O and N.C. auxiliary contact(s).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 26 05 29 "Hangers and Supports for Electrical Systems."
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in each fusible-switch enclosed controller.
- D. Install fuses in control circuits if not factory installed. Comply with requirements in Section 26 28 13 "Fuses."

- E. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- F. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- G. Install power factor correction capacitors. Connect to the line side of overload relays.
- H. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved nameplate.
 - 3. Label each enclosure-mounted control and pilot device.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 - 2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
 - 3. Test continuity of each circuit.
 - 4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect before starting the motor(s).
 - 5. Test each motor for proper phase rotation.
 - 6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed controllers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.
- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect before increasing settings.
- D. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 05 73 "Overcurrent Protective Device Coordination Study."

3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.
- B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers

END OF SECTION 26 29 13

516 N. KING ST, WILMINGTON DE 19801
#MJ0217000003-BP4

CUSTOM HOUSE RENOVATION AND ADDITION
NOVEMBER 22, 2024

ENCLOSED CONTROLLERS
26 29 13 - 10

NOT FOR BID

WSP
TA PROJECT NO. 13670.00

SECTION 26 32 13
ENGINE GENERATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Engine Generator are purchased as part of a separate pre-purchase package. Contractor responsible for installation and testing under this contract.
- B. This Section includes packaged engine-generator sets for emergency power supply with the following features:
 - 1. Natural gas engine.
 - 2. Unit mounted cooling system.
 - 3. Unit mounted control and monitoring.
 - 4. Performance requirements for sensitive loads.
 - 5. Outdoor enclosure.
- C. Related Sections include the following:
 - 1. Section 263600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.3 DEFINITIONS

- A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.
- B. Qualification Data: For installer, and manufacturer.
- C. Source quality-control test reports.
 - 1. Certified summary of prototype-unit test report.
 - 2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
 - 3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.

4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
5. Report of sound generation.
6. Report of exhaust emissions showing compliance with applicable regulations.
7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

D. Field quality-control test reports.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
1. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
 2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with ASME B15.1.
- D. Comply with NFPA 37.
- E. Comply with NFPA 70.
- F. Comply with NFPA 99.
- G. Comply with NFPA 110 requirements for Level 1 emergency power supply system.
- H. Comply with UL 2200.
- I. Engine Exhaust Emissions: Comply with applicable federal, state and local government requirements, EPA Tier certified.
- J. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.5 COORDINATION

- A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.6 WARRANTY

- A. Provide 5-year extended manufacturer warranty.
- B. The warranty period shall start at the date of overall substantial completion for the project.
- C. Submit a sample warranty for approval before purchasing equipment.
- D. See section 01 77 00 – Closeout Procedures for additional warranty requirements.

PART 2 - PRODUCTS

2.1 PREPURCHASE PACKAGE

- A. Engine Generator purchased under separate Prepurchase package.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.
- B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.
- B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- C. Install packaged engine generator with restrained spring isolators having a minimum deflection of 1 inch on 4-inch-high concrete base. Secure sets to anchor bolts installed in concrete bases.
- D. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.
- B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.
- C. Connect engine exhaust pipe to engine with flexible connector.
- D. Connect fuel piping to engines with a gate valve and union and flexible connector.
 - 1. Natural-gas piping, valves, and specialties for gas distribution are specified in Section 231123 "Facility Natural-Gas Piping."
- E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 IDENTIFICATION

- A. Identify system components according to Section 230553 "Identification for HVAC Piping and Equipment" and Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
 - 3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
 - a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.

- b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
 - c. Verify acceptance of charge for each element of the battery after discharge.
 - d. Verify that measurements are within manufacturer's specifications.
4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch WG. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
7. Exhaust Emissions Test: Comply with applicable government test criteria.
8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
9. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
10. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.
11. All safety shutdown points shall be set, tested, and recorded. Recording charts shall be made of voltage and frequency for all load changes.
12. Load Test:
 - a. The engine shall be connected to the loads it is intended to serve. Normal power will be removed and the generator will pick up load from a 'cold start' position. The time delay, crank time, time to reach operating speed, voltage and frequency overshoot, time to reach steady state with emergency loads connected shall be observed and times recorded. The generator voltage, amperes, frequency, oil pressure, and water temperature shall be recorded. The battery charge rate shall be recorded at 5 minutes and then 15 minute intervals thereafter. The generator shall run for 2 hours observing and recording any changes in voltage and frequency. After two hours the normal power will be restored. The time delay to retransfer (minimum 5 minutes) shall be observed and recorded. The time delay for generator cooldown/shutdown shall be observed and recorded.
 - b. The generator will be allowed to cool for 5 minutes. The generator will be restarted and a 80% lagging power factor load shall be applied for 2 hours. The generator voltage, amperes, frequency, oil pressure, and water temperature shall be recorded at 15 minute intervals for the duration of the test.
 - c. The cold start test shall be performed to demonstrate time required to pick up load. The time to pick up load shall be as measured from the time the normal source is disconnected to an automatic transfer switch, until the transfer switch connects to the normal source. The contractor shall utilize a

recording meter, connected to a suitable emergency panel, to accurately measure (within 0.1 seconds) the time elapsed from removal of voltage to restoration. Submit time vs. voltage printouts from the recording meter for incorporation into the project manual.

- C. Coordinate tests with tests for transfer switches and run them concurrently.
- D. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.
- E. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- H. Remove and replace malfunctioning units and retest as specified above.
- I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

END OF SECTION 26 32 13

SECTION 26 36 00
TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Transfer switches are purchased as part of a separate pre-purchase package. Contractor responsible for installation and testing under this contract.
- B. This Section includes transfer switches rated 600 V and less, including the following:
 - 1. Automatic transfer switches.
 - 2. Remote annunciation systems.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NEMA ICS 1.
- C. Comply with NFPA 70.
- D. Comply with NFPA 99.
- E. Comply with NFPA 110.
- F. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.5 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."

PART 2 - PRODUCTS

2.1 PREPURCHASE PACKAGE

- A. Transfer switch purchased under separate Prepurchase package.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Floor-Mounting Switch: Anchor to floor by bolting.
 - 1. Concrete Bases: 4 inches high, reinforced, with chamfered edges. Extend base no more than 4 inches in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Section 260529 "Hangers and Supports for Electrical Systems."
- B. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.
- C. Identify components according to Section 26 05 53 "Identification for Electrical Systems."
- D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

- A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
- B. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

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.
1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
 - a. Check for electrical continuity of circuits and for short circuits.
 - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
 - c. Verify that manual transfer warnings are properly placed.
 - d. Perform manual transfer operation.
 4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
 - a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
 - f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
 - g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
 5. Ground-Fault Tests: Coordinate with testing of ground-fault protective and indicating devices for power delivery from both sources.
 - a. Verify grounding connections and locations and ratings of sensors.
 - b. Observe reaction of circuit interrupting devices when simulated fault current is applied at sensors.
- B. Tests and Inspections:
1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
 - a. Check for electrical continuity of circuits and for short circuits.
 - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
 - c. Verify that manual transfer warnings are properly placed.
 - d. Perform manual transfer operation.
 4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
 - a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
 - f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
 - g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
 5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
 - a. Verify grounding connections and locations and ratings of sensors.
- C. Coordinate tests with tests of generator and run them concurrently.
- D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- E. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 26 36 00

SECTION 26 41 13

LIGHTNING PROTECTION FOR STRUCTURES

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 lightning protection for structures.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For air terminals and mounting accessories.
 - 1. Layout of the lightning protection system, along with details of the components to be used in the installation.
 - 2. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.
- B. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.
- C. Field quality-control reports.
- D. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.
- E. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:
 - 1. Ground rods.
 - 2. Ground loop conductor.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Certified by UL, trained and approved for installation of units required for this Project.
- B. System Certificate:
 - 1. UL Master Label.
 - 2. UL Master Label Recertification.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

1.6 COORDINATION

- A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.
- B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.
- C. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

PART 2 - PRODUCTS

2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS

- A. Comply with UL 96 and NFPA 780.
- B. Roof-Mounted Air Terminals: NFPA 780, Class II, copper unless otherwise indicated.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. East Coast Lightning Equipment Inc.
 - b. ERICO International Corporation.
 - c. Harger.
 - d. Heary Bros. Lightning Protection Co. Inc.
 - e. Independent Protection Co.
 - f. Preferred Lightning Protection.
 - g. Robbins Lightning, Inc.
 - h. Thompson Lightning Protection, Inc.
 - 2. Air Terminals More than 24 Inches (600 mm) Long: With brace attached to the terminal at not less than half the height of the terminal.

- 3. Single-Membrane, Roof-Mounted Air Terminals: Designed specifically for single-membrane roof system materials. Comply with requirements in roofing Sections.
- C. Main and Bonding Conductors: Copper.
- D. Ground Loop Conductor: The same size and type as the main conductor except tinned.
- E. Ground Rods: Copper-clad steel, sectional type; 3/4 inch in diameter by 10 feet long.
- F. Heavy-Duty, Stack-Mounted, Lightning Protection Components: Solid copper.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install lightning protection components and systems according to UL 96A and NFPA 780.
- B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.
- C. Conceal the following conductors:
 - 1. System conductors.
 - 2. Down conductors.
 - 3. Interior conductors.
 - 4. Conductors within normal view of exterior locations at grade within 200 feet of building.
- D. Cable Connections: Use crimped or bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.
- E. Cable Connections: Use exothermic-welded connections for all conductor splices and connections between conductors and other components.
 - 1. Exception: In single-ply membrane roofing, exothermic-welded connections may be used only below the roof level.
- F. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.
- G. Bond extremities of vertical metal bodies exceeding 60 feet in length to lightning protection components.
- H. Ground Loop: Install ground-level, potential equalization conductor and extend around the perimeter of structure.
 - 1. Bury ground ring not less than 24 inches from building foundation.

2. Bond ground terminals to the ground loop.
 3. Bond grounded building systems to the ground loop conductor within 12 feet of grade level.
- I. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot intervals.

3.2 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.3 CORROSION PROTECTION

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
- B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.4 FIELD QUALITY CONTROL

- A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.
- B. UL Inspection: Meet requirements to obtain a UL Master Label for system.

END OF SECTION 26 41 13

SECTION 26 51 00

INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Interior lighting fixtures.
 - 2. Emergency lighting units.
 - 3. Exit signs.
 - 4. Lighting fixture supports.

- B. Related Sections:

- 1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
 - 2. Section 262726 "Wiring Devices" for manual wall-box dimmers for LED sources.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color-rendering index.
- C. LER: Luminaire efficacy rating.
- D. Lumen: Measured output of luminaire.
- E. Luminaire: Complete lighting fixture, including driver housing if provided.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of lighting fixture including dimensions.

2. Emergency lighting units including battery and charger.
3. Energy-efficiency data.
4. Life, output (lumens, CCT, and CRI), and energy-efficiency data for LEDs.
5. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for accessories identical to those indicated for the lighting fixture as applied in this Project.

- a. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

6. Wiring Diagrams: For power, signal, and control wiring.

- B. Installation instructions.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Lighting fixtures.
2. Suspended ceiling components.
3. Partitions and millwork that penetrate the ceiling or extends to within 12 inches of the plane of the luminaires.
4. Ceiling-mounted projectors.
5. Structural members to which suspension systems for lighting fixtures will be attached.
6. Other items in finished ceiling including the following:

- a. Air outlets and inlets.
- b. Speakers.
- c. Sprinklers.
- d. Smoke and fire detectors.
- e. Occupancy sensors.
- f. Access panels.

7. Perimeter moldings.

- B. Field quality-control reports.

- C. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and 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. Fixtures: One for every 10 of each type and rating installed. Furnish at least two of each type.
 - a. Entire fixture including housing, driver, lamp and lens fully assembled shall be furnished as spare.

1.8 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70.

1.9 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.10 WARRANTY

- A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Emergency Lighting Unit Batteries (including Self-Powered Exit Signs): Ten years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
- B. Provide 3-year manufacturer warranty for LED luminaires, including drivers.
- C. The warranty period shall start at the date of overall substantial completion for the project.
- D. Submit a sample warranty for approval before purchasing equipment.
- E. See section 01 77 00 – Closeout Procedures for additional warranty requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements provide one of the products indicated on Drawings. **Lighting fixtures not included in the schedule are not acceptable and should not be submitted as substitutions, unless submitted and approved prior to bidding.**

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Metal Parts: Free of burrs and sharp corners and edges.
- C. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
- D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during replacement of LED sources and components and when secured in operating position.
- E. Diffusers and Globes:
1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
 - b. UV stabilized.
 2. Glass: Annealed crystal glass unless otherwise indicated.
- F. Factory-Applied Labels: Comply with UL 1598. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
1. Label shall include the following luminaire characteristics:
 - a. Rated delivered lumens.
 - b. CCT and CRI for all luminaires.
- G. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic interference as required by MIL-STD-461E. Fabricate lighting fixtures with one filter on each driver indicated to require a filter.

2.3 LED SOURCES

- A. Minimum lumen output, as indicated in the lighting fixture schedule on the drawings, shall be initial lumens exiting the luminaire in the 0-90 degree zone, as measured by an accredited laboratory, per IESNA Standard LM-79-08.
 - 1. Fixtures lumens shall match lumen output indicated on lighting fixture schedule +10% / -5%.
- B. Lumen output shall not decrease more than 20% over an operational life of at least 50,000 hours.
- C. Individual LED's shall be connected such that failure of one LED will not result in loss of light from the entire luminaire.
- D. LED boards shall be suitable for field maintenance or service above or below the ceiling, using plug-in connectors. LED boards shall be upgradable.
- E. Color rendering index (CRI) shall be 80 or greater. Color shift shall be <0.007 over 6000 hours.
- F. LED lighting fixtures shall be designed as an integrated assembly, with the LED sources, driver(s), housing, and optics all designed to function optimally as a complete assembly. Retrofits or adaptations of fixture primarily intended for incandescent, HID, or fluorescent sources will not be permitted.
- G. Indoor LED fixtures shall be thermally stable over the life of the fixture, in an operating temperature range of 0 to 25 degrees Celsius. Thermal management shall be passive in design, without use of cooling fans.

2.4 LED DRIVERS

- A. LED dimming shall be equal in range, quality, and character to that achieved by specification-grade, architectural wall box dimming controls applied to incandescent sources.
- B. Rated design life shall be 50,000 hours, and drivers shall carry a five-year replacement warranty or warranty as indicated on drawings, whichever is greater.
- C. Input voltage shall be universal type, allowable range 108 to 305 V (120-277 +/- 10%) AC.
- D. Quality of dimming shall be defined by dimming range, lack of perceptible flicker or stroboscopic effect, smooth and continuous linear changes in level without steps, natural square law response to control input, stability throughout rated voltage range, consistent color appearance over dimming range, and symmetrical response to raise / lower control inputs.

- E. Demonstration of compliance shall be required where requested by the Architect. Drivers which are not acceptable to the Architect, shall be replaced at no cost to the Owner.
- F. Operating temperature range shall be -30 to 50 degrees Celsius.
- G. Flicker index shall be less than 1% at all frequencies less than 1000Hz.
- H. Control input shall be 4-wire 0-10VDC voltage controlled, capable of sinking 0.6mA per driver at a low end of 0.3V.
- I. Total harmonic distortion (THD) shall not exceed 10%, minimum power factor shall be 90%. Drivers shall conform to the electro-magnetic interference (EMI) limits established by the Federal Communications Commission (FCC), part 18, for industrial (Class A) applications.
- J. Drivers shall include listing as a UL-Recognized component.

2.5 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 - 1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.

2.6 EMERGENCY LIGHTING UNITS

- A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.
 - 1. Battery: Sealed, maintenance-free, lead-acid type.
 - 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - 3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - 4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - 5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - 6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
 - 7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.7 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Section 260529 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.
- F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures:
 - 1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
- B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, and reinstall.
- C. Remote Mounting of Drivers and Power Supplies: Distance between the driver or power supply and fixture shall not exceed that recommended by the manufacturer. Verify, with manufacturers, maximum distance between driver or power supply and luminaire. Where remote driver or power supply locations are not indicated on plan, coordinate location with Owner and Architect in field.
- D. Lay-in Ceiling Lighting Fixtures Supports: Do not use grid as a support element.
 - 1. Install at least two independent support rods or wires from structure to a tabs on opposite corners of lighting fixture. Wires or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
- E. Suspended Lighting Fixture Support:
 - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.

3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
 4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.
- F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 IDENTIFICATION

- A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 26 51 00

SECTION 26 83 13

RADIANT-HEATING ELECTRIC CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes electric heating cables for surface snow melting with the following electric heating cables:
 - 1. Surface Snow Melting: Self-regulating, parallel resistance.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include the following:
 - a. Heating product data sheet.
 - b. UL-listed certificates for heating product.
 - c. System installation and operation manual.
 - d. System installation details.
 - e. Connection kits and accessories data sheet.
 - f. Controller/thermostat data sheet.
 - g. Controller/thermostat wiring diagram.
 - 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
 - 3. Schedule heating capacity, length of cable, and electrical power requirement for each electric heating cable required.
 - 4. Include design calculations for each application.
- B. Shop Drawings: For electric heating cable.
 - 1. Include plans, sections, and attachment details.
 - 2. Include diagrams for power, signal, and control wiring.
 - 3. Include designs for floor-heating layout(s) in floor assembly.
 - 4. Manufacturer to produce detailed design as described below.

- C. Delegated Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Delegated design submittals include the following:
1. Surface Snow Melting Layout Drawings: Drawings to be provided, including the following:
 - a. Location/identification of area to be traced.
 - b. Area dimensions.
 - c. Expansion joints, crack control, and trench locations.
 - d. Heater circuit number.
 - e. Watt density.
 - f. Electrical load.
 - g. Heater catalog number.
 - h. Heater termination points.
 - i. Startup temperature.
 - j. Pavement profile details.
 - k. Location of all components
 - l. Material list of all components and quantities used.
 - m. Heating cable layout.
 2. Surface Snow-Melting Installation Detail Drawings: Project-specific Detail Drawings, including details showing the following:
 - a. Expansion joints.
 - b. Crack control joints.
 - c. Trenches.
 - d. Junction boxes.
 - e. Pavement.
 - f. Sensor.
 3. Control Panel Drawings: Drawings for each control panel to include the following:
 - a. Physical arrangement and structural Detail Drawings.
 - b. Complete power and control wiring diagrams showing all internal wiring connections for electrical and instrument components in each control panel. All wires, terminals, and devices are numbered and tagged in accordance with system elementary diagrams.
 4. System Wiring Diagram: Project-specific Drawings (if applicable) including the following:
 - a. Interconnect of all major components.
 - b. Assignment of circuiting.
 - c. Connection of circuit wiring in terminal blocks.
 - d. Connection of sensor wiring.
 - e. Connection of external alarm wiring.
 5. Controller Set-Point Schedule (If applicable) showing the following:

- a. Circuit addresses.
 - b. Circuit set points.
 - c. Circuit alarms and settings.
- 6. Power Distribution Panel Board Schedules (If applicable) showing the following:
 - a. Heat tracing circuit allocation.
 - b. Breaker size.
 - c. Voltage and wattage.
 - d. Operating load amperes.
- D. Testing Instructions and Reporting Form: Provide documentation for use in preinstallation testing of heat tracing system.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.
- B. Testing: Completed system test report.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. ISO-09001 registered.
 - 2. Provide products with CSA 22.2 No 130-16 certification and/or UL 515 listing, consistent with IEEE 515.1 requirements.
- B. Installer Qualifications:
 - 1. System Installer to have complete understanding of product and product literature from manufacturer or authorized representative prior to installation.
 - 2. Electrical connections to be performed by licensed electrician.
- C. Certification: System (Heating Cable, Connection Kits, and Controller): UL Listed, CSA Certified roof and gutter de-icing, surface snow melting, and/or floor-heating systems.
- D. Testing: Heating cable for surface snow melting systems to be qualified and tested to demonstrate a useful lifetime in excess of 20 years.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in original, unopened containers or packages with intact and legible manufacturers' labels identifying the following:
 - 1. Product and /manufacturer.
 - 2. Length/quantity.
 - 3. Lot number.
 - 4. Installation and operation manual.
 - 5. Material safety data sheet (MSDS) (if applicable).
- B. Store heating cable in clean, dry location with a temperature range of 0 to 140 deg F
- C. Protect heating cable or heating mats from mechanical damage.
- D. Protect heating cable ends from moisture ingress until final termination of heating cable is complete.

1.8 WARRANTY

- A. Manufacturer's Limited Warranty: Manufacturer agrees to repair or replace electric heating products listed below that fail in materials or workmanship within specified warranty period, when such goods are properly installed, operated, and maintained in accordance with product documents.
 - 1. Covered products include the following:
 - a. Heating cables, connection kits, and accessories.
 - b. Thermostats, controllers, panels, contactors, sensors, and accessories.
 - 2. Warranty Period for Heating Cable: Two years from date of Substantial Completion.
- B. Manufacturer's Extended Warranty: Provide Owner an extended product warranty for heat tracing products described below.
 - 1. Contractor must complete and forward to Owner the Installation, Inspection, or Commissioning Record(s), and complete manufacturer's online warranty registration form within 30 days from date of installation; otherwise, only standard limited warranty applies.
 - 2. Warranty Period for Heating Cable: 10 years from date of Substantial Completion.
 - 3. Warranty Period for Concealed Roof Ice Melt Panels and Components: 20 years from date of Substantial Completion.
 - 4. Heating cables, panels, and components not automatically offered with an extended manufacturer's warranty, as a standard matter of course, will not be allowed.
 - 5. Warranty information must be published on manufacturer's website.
- C. Manufacturer's Limited Warranty: Manufacturer agrees to repair or replace electric heating products listed below that fail in materials or workmanship within specified

warranty period, when such goods are properly installed, operated, and maintained in accordance with product documents.

1. Covered products include the following:
 - a. Heating cables, connection kits, and accessories.
 - b. Thermostats, controllers, panels, contractors, sensors, and accessories.
 2. Warranty Period for Heating Products: Non-prorated 25 years from date of product purchase when installed in accordance with manufacturer's written instructions under ceramic tile, marble, other natural stone, laminate, engineered wood, or luxury vinyl floor coverings.
 3. Warranty Period for Floor Heating Controller/Thermostat: Non-prorated three years from date of product purchase when installed in accordance with manufacturer's written instructions.
- D. Manufacturer's Extended Warranty: Provide Owner an extended product warranty for floor-heating products described below.
1. This special warranty extends the period of limitations contained in the General Conditions. Countersign warranty by Installer and manufacturer.
 2. When installation of floor-heating product(s) are completed by Contractor with a valid professional installer certification program registration number, the complete flooring covering assembly (including labor and floor covering materials) is covered by a non-prorated 25-year warranty.
 3. Contractor must complete manufacturer's online warranty registration within 30 days from date of installation and in accordance with procedures outlined in the warranty documentation; otherwise, the standard limited warranty applies.
 4. Warranty information must be published on manufacturer's website.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR ELECTRIC HEATING CABLES

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Source Limitations: All system components to be sourced from a single manufacturer, under no circumstances are any components installed other than those supplied by cable manufacturer, to ensure system integrity and to meet warranty requirements.

2.2 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES - SNOW MELTING

- A. Basis-of-Design Product: Subject to compliance with requirements, provide RAYCHEM; a brand of nVent; ElectroMelt Surface Snow Melting or equal by alternate manufacturer.

- B. System Description; Complete surface snow-melting system for concrete. System consists of self-regulating heating cable, connection kits, accessories, and temperature and moisture sensing control; monitoring; integrated ground-fault circuit protection; and BMS communication capabilities.
 - 1. System spacing requirements based on supply voltage, application, and location. Generally, the required watt density for a snow melting application in the Northeast US will be 35 to 45 W per square foot. This system will operate on 208V.
- C. Compliance: UL 515, CSA 22.2 No 130-16, and IEEE 515.1.
- D. Heating Element: Pair of parallel No. 14 AWG, nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable is capable of crossing over itself once without overheating.
- E. Electrical Insulating Inner Jacket: Modified polyolefin.
- F. Cable Cover: Tinned-copper braid with polyolefin outer jacket.
 - 1. Outer jacket printed with cable model number, agency listings, batch number, and meter marks (for ease of installation within maximum circuit length).
- G. Heating cable has a self-regulating factor of at least 70 percent. Self-regulating factor is defined as the percent reduction of the heating cable power output going from a 0 to 80 deg F temperature.
- H. Voltage: 208V without use of transformers.
- I. Heating cable to be part of a UL Listed and CSA Certified system.
- J. Heating Cable Connection Kits:
 - 1. Power Connection and End Seal Kit: Provides a safety agency approved cold lead cable (UL Listed UF-B cable for the USA, or a CSA Certified NMWU cable for Canada) to run between a junction box and heating cable to be embedded in concrete, a crimp and heat shrink connection between cold lead and heating cable, and a heat shrink end seal for the heating cable to be embedded in concrete.
 - a. Basis-of-Design Product: RAYCHEM; EMK-XC-USA for the USA.
 - 2. Heating Cable Splice Kit: Provides a crimp and heat shrink connection between two sections of heating cable to be embedded in concrete. The kit can be used either for replacing damaged sections of heating cable or joining two shorter sections into a longer heating cable, not to exceed the maximum recommended circuit length for the circuit breaker size being used.
 - a. Basis-of-Design Product: RAYCHEM; EMK-XS.
 - 3. Expansion Joint Kit: Provides physical protection for the heating cable beneath slab joints. Use an expansion tube to form an expansion loop for the heating cable.

- a. Basis-of-Design Product: RAYCHEM; EMK-XEJ.
- 4. Junction Box: 134 cu. in., UL Listed or CSA Certified weatherproof enclosure suitable for terminating the heating cable circuit. Enclosure is made of painted steel and provides high impact strength, and excellent weathering capabilities. Junction box is large enough for two circuits of heating cables.
 - a. Basis-of-Design Product: RAYCHEM; EMK-JB.
 - b. Custom junction boxes are allowable. There must be at least 48 cu. in. per connection.
- 5. Crack Control Joint Kit: Provides physical protection for the heating cable crossing crack control joints. Use a crack control join kit for the heating cable per one joint crossed.
 - a. Basis-of-Design Product: RAYCHEM; EMK-XCJ.
- 6. Snow-Melting Caution Sign; As required by national electrical codes to indicate that an electrical snow melting system is installed in slab.
 - a. Basis-of-Design Product: RAYCHEM; SMCS.
- K. Controls:
 - 1. Single-Circuit Local Digital Control System:
 - a. Single-circuit snow/ice melting controller:
 - 1) Basis-of-Design Product: Raychem; APS-4C with SC-40 satellite contactor.
 - b. Heating cable manufacturer provides a single-circuit snow/ice melting controller with built-in GFPD compatible with selected heating cable.
 - c. Electronic snow/ice melting controller has GFPD with adjustable trip levels of 30, 60, and 120 mA.
 - d. Electronic snow/ice melting controller has 50 A switching capacity rating.
 - e. Electronic snow/ice melting controller is capable of operating with supply voltages of 120, and 208 to 240 V.
 - f. Electronic snow/ice melting controller is capable of supporting up to six aerial or slab mounted temperature and moisture sensors.
 - 1) Basis-of-Design Product: Raychem; Type Snow Owl aerial and Type SIT-6E, slab-mounted.
 - g. Enclosure Type: NEMA 3R polycarbonate.
 - h. Electronic snow/ice melting controller has an adjustable hold-on timer (zero to 10 hours).
 - i. Electronic snow/ice melting controller has an integrated high-limit temperature sensor.

- j. Electronic snow/ice melting controller shall have contacts (10 mA dry switch contact) to interface with EMC.
 - 1) Inputs: Override On, Override Off.
 - 2) Outputs: Supply, Snow, Heat, High Temp, Alarm.
- k. Digital controller has c-UL-us approvals.
- l. Power Control Panels:
 - 1) Basis-of-Design Products: Raychem; ACS-PCM2-5.
 - 2) Certification: c-UL-us Listed.
 - 3) Enclosure: NEMA 4/12 enclosure approved for nonhazardous indoor and outdoor locations.
 - 4) Provide ground-fault and line current sensing alarming, switching and temperature inputs for five heat-tracing circuits.
 - 5) Contactors: Five 3-pole, 30A contactors, EMR type.
 - 6) Capable of operating at 120 to 277 V.
 - 7) Alarm contact, including alarm light on panel cover.
- m. Controllers may be added to the control system for single-circuit extensions.
 - 1) Basis-of-Design Product: Raychem; C910-485.
- n. Temperature Inputs: Digital control system is capable of assigning up to four temperature inputs per heat-tracing circuit.
 - 1) Basis-of-Design Product: Raychem; RTD.
- o. Remote Monitoring Modules: User Interface Terminal is capable of communicating with up to 16 remote monitoring modules, where each module is capable of accepting up to eight temperature inputs.
 - 1) Basis-of-Design Product: Raychem; RMM2.
- p. User Interface Terminal has the following:
 - 1) USB port to allow for quick and easy software updates.
 - 2) Three programmable alarm contacts, including an alarm light on enclosure cover.
- q. Provide separate offline software tool to allow users to preprogram digital control system and transfer program via USB drive or Ethernet.
- r. User Interface Terminal Enclosure: NEMA 4 for indoor or outdoor locations.
- s. Power Control Panel Enclosures: NEMA 4/12 enclosure approved for nonhazardous indoor and outdoor locations.
- t. Power control panel provides ground-fault and line current sensing alarming, switching, and temperature inputs for five heat tracing circuits.
- u. Each power control panel has five 3-pole, 30 A contactors (EMR type).
- v. Digital Controller:

- 1) Integrated adjustable GFPD (10 to 200 mA).
- 2) Capable of being configured for On/Off, ambient sensing, PASC, and timed duty cycle control modes based on application. PASC control proportionally energizes power to heating cable to minimize energy based on ambient sensed conditions.
- 3) Upon communication loss with user interface terminal, panels shall control with last downloaded set point.
- 4) Include built-in self-test feature to verify proper functionality of heating cable system.
- 5) BMS Communication Protocol: By BACnet.
- 6) Variables monitored by digital controller and reported back to BMS include:
 - a) Temperature.
 - b) Ground-fault.
 - c) Current draw.
 - d) Power consumption.
 - e) Associated alarms.

L. Approval:

1. System (heating cable, connection kits, and controller) to be UL Listed, CSA Certified for surface snow melting of concrete.
2. Snow-melting system has a design, installation and operating manual specific to surface snow melting.

PART 3 - EXECUTION

3.1 SURFACE SNOW MELTING

A. Examination:

1. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - a. Ensure that surfaces in contact with electric heating cables are free of burrs and sharp protrusions.
 - b. Ensure that surfaces and substrates are level and plumb.
2. Preinstallation Testing:
 - a. Prior to installing heating cable, an insulation resistance test is performed by installing Contractor to ensure integrity of heating cable as described in installation and maintenance manual.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation:

1. Protect all heating cable ends from moisture ingress until cable is terminated with end seals.
2. Protection of In-Place Conditions:
 - a. If there is any delay between installation of heating cables and placement of topping course, take the following precautions to protect the installation:
 - 1) Record post-installation test results immediately.
 - 2) Do not energize cables.
 - 3) Mechanically protect cables so they cannot be damaged by pedestrian or vehicular traffic, paint, welding, falling objects, inclement weather, or other inappropriate exposure.

C. Installation, Surface:

1. Cable:
 - a. Install heating cable in accordance with national and local electrical codes, manufacturer's written instructions, and instructions provided with heating cable and components.
 - b. Lay cables such that sheaths do not touch or cross one another. Concrete expansion and/or crack-control joints to be crossed in accordance with specific procedures provided by manufacturer.
 - c. Lay cables at spacing specified in construction documentation.
 - d. For MI cable, spacing must not exceed 10 inches in concrete or 6 inches in asphalt, to promote equal heat distribution at the surface.
 - e. Locate junction boxes in accessible areas, above grade (unless indoors). Junction boxes are not located in heated slab. Keep covers on enclosures when not working therein.
 - f. Protect terminations from weather and from mechanical damage. Gland assembly is bonded to system ground. When fishing cable cold leads through conduit, cold lead tails are not pulled.
 - g. Field alterations or deviations to proceed only after authorization issued by Project engineering team. All changes are accurately recorded by Contractor and provided to engineer at completion of that phase of work.
 - h. After laying heating cable, perform same tests as outlined in manufacturer's installation manual, and record results in same Results table. Continuity test reading should be the same; Insulation Resistance test reading should exceed 1,000 MΩ. Notify construction team of unsatisfactory test results and stop work in that area until issue is rectified. Cable manufacturer is capable of assisting with troubleshooting.

D. Installation, Embedded:

1. Do not energize cables embedded in concrete until those assemblies are cured.
2. All heat tracing components including power connections, splices, tees, crosses, or end seal, must be installed above grade and protected from abuse or damage. By NEC and CEC, electrical connections are not permitted to be installed below grade.
3. Install heating cable with heat-conductive fill materials such as concrete to ensure direct contact with finished radiant surfaces.

4. Stamp concrete with embedded electric heating-cable identification in accordance with NFPA 70 and complying with requirements in Section 033000 "Cast-in-Place Concrete."

E. Sensors and Controllers

1. General:

- a. Mount sensors in upright position in an area clear of overhead trees, wires, eaves, and similar, and not at risk from falling debris. Avoid exposure to artificial heat-sources and shock vibration.
- b. Select location representative of anticipated precipitation conditions in area(s) where snow-melting system is installed.
- c. Mount precipitation sensor in pavement.
- d. Provide power for sensor in accordance with electrical codes and standards.

2. Slab temperature sensor for the following:

a. Group Control and Power Distribution Panel:

- 1) Install metallic conduit, 3/4 inch- minimum diameter, for accommodation of the slab thermistor between runs of heating cable prior to topping course pour. Conduit shall not cross runs of heating cable, and to end no less than 18 inches within heated section of slab. Seal conduit at its extent to prevent ingress of paving material during pour and moisture after.
- 2) After topping course is complete, insert slab temperature sensor to end of previously installed conduit. Use fish tape (or similar) to push thermistor in, and abandon in-place, for the dual purpose of ensuring it gets to end and allowing future removal.

b. Distributed Control Network:

- 1) Install metallic conduit, 3/4 inch minimum diameter, for accommodation of the slab-sensing RTD between runs of heating cable prior to topping course pour. Conduit to not cross runs of heating cable, and to end no less than 18 inches within heated section of slab. Seal conduit at its extent to prevent ingress of paving material during pour and moisture after.
- 2) After topping course is complete, insert slab temperature sensor (RTD) to end of previously installed conduit. Use fish tape (or similar) to push thermistor in, and abandon in-place, for the dual purpose of ensuring it gets to end and allowing future retrieval without undue tension on sensor assembly itself.

3. Energy-Efficient Control System:

a. Group Control and Power Distribution Panel:

- 1) Mount panel in accordance with manufacturer's installation and operating manuals and applicable codes and standards.

2) Power and control wiring is made safe prior to energizing panel.

b. Distributed Control Network:

- 1) Mount panels in accordance with manufacturer's installation and operating manuals, and applicable codes and standards.
- 2) Set control module addresses prior to energizing system. Avoid duplication of addresses.
- 3) Power and control wiring is made safe prior to energizing panel. Energize circuits in order specified in installation and operating manuals to ensure network connectivity.

F. Connections:

1. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
2. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

G. Field Quality Control:

1. Manufacturer's Field Service: Initial start-up and field testing (commissioning) of system is performed by factory technician in accordance with Owner's requirements.
2. Contractor to perform the following tests and inspections during installation:
 - a. Heating cable is tested for insulation resistance when received at Project site before installation.
 - b. Heating cable is tested for insulation resistance after installation, but before insulation is installed.
 - c. Heating cable is tested for insulation resistance after insulation is installed.
 - 1) Insulation resistance must exceed 1000 megohms at 2500 V dc.
 - d. All results must meet manufacturer's specification.
 - e. Test cables for electrical insulation integrity throughout installation.
 - 1) Be prepared to halt installation of topping material if a break in the insulation integrity is identified.
 - 2) Block out areas of damaged cable for later repair. Leave 18 inches exposed on either side of cable to make splice repair.
 - 3) Resume pour once area for splice is in place.
 - f. Test insulation integrity before energizing.
 - g. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
 - h. Repeat tests for continuity, insulation resistance, and input power after applying finished surface on heating cables.
3. Electric heating cables will be considered defective if they do not pass tests and inspections in accordance with manufacturer's requirements.

4. Technician to verify that the controller parameters are set to the application requirements.
5. Technician to verify that RAYCHEM's "ACS-30" and "ProtoNode®" device server (if applicable) are configured correctly with the BMS.
6. Provide factory-certified technician or manufacturer's representative for a start-up and commissioning of heat tracing system and controller.
7. Prepare test and inspection reports.

H. Protection:

1. Protect installed heating cables, including nonheating leads, from damage and moisture ingress during construction.
2. Remove and replace damaged electric heating cables.
3. Comply with manufacturer's written instructions for maintenance service.

3.2 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system in accordance with Section 01 79 00 "Demonstration and Training."
- B. Provide video recording of training in accordance with Section 01 79 00 "Demonstration and Training."

END OF SECTION 26 83 13

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SECTION 27 05 26

GROUNDING AND BONDING FOR COMMUNICATIONS 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. Grounding conductors.
 - 2. Grounding connectors.
 - 3. Grounding busbars.
 - 4. Grounding rods.
 - 5. Grounding labeling.

1.3 DEFINITIONS

- A. BCT: Bonding conductor for telecommunications.
- B. TGB: Telecommunications grounding busbar.
- C. TMGB: Telecommunications main grounding busbar.
- D. Service Provider: The operator of a service that provides telecommunications transmission delivered over access provider facilities.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For communications equipment room signal reference grid. Include plans, elevations, sections, details, and attachments to other work.

1.5 INFORMATIONAL SUBMITTALS

- A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:

1. Ground rods.
 2. Ground and roof rings.
 3. BCT, TMGB, TGBs, and routing of their bonding conductors.
- B. Qualification Data: For installation supervisor, and field inspector.
- C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Result of the ground-resistance test, measured at the point of BCT connection.
 - b. Result of the bonding-resistance test at each TGB and its nearest grounding electrode.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
1. Installation Supervision: Installation shall be under the direct supervision of ITS Technician, who shall be present at all times when Work of this Section is performed at Project site.
 2. Field Inspector: Currently registered by BICSI as Technician to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.
- C. Comply with TIA-607-B.

2.2 CONDUCTORS

- A. Comply with UL 486A-486B.

- B. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.
 - 1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
 - 2. Cable Tray Equipment Grounding Wire: No. 8 AWG.
- C. Cable Tray Grounding Jumper:
 - 1. Not smaller than No. 10 AWG and not longer than 12 inches. If jumper is a wire, it shall have a crimped grounding lug with one hole and standard barrel for one crimp. If jumper is a flexible braid, it shall have a one- or two-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.
- D. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B3.
 - 2. Stranded Conductors: ASTM B8.
 - 3. Tinned Conductors: ASTM B33.
 - 4. Bonding Cable: 28 kcmils, 14 strands of No. 17 AWG conductor, and 1/4 inch in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.3 CONNECTORS

- A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.
- B. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.
 - 1. Electroplated tinned copper, C and H shaped.
- C. Signal Reference Grid Connectors: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.
- D. Busbar Connectors: Cast silicon bronze, solderless compression-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.
- E. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING BUSBARS

- A. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches in cross section, 18 inches in length. The busbar shall be NRTL listed for use as TMGB and shall comply with TIA-607-B.
 - 1. Predrilling shall be with holes for use with lugs specified in this Section.
 - 2. Mounting Hardware: Stand-off brackets that provide a 4-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
 - 3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.
- B. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches in cross section, 12 inches in length. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with TIA-607-B.
 - 1. Predrilling shall be with holes for use with lugs specified in this Section.
 - 2. Mounting Hardware: Stand-off brackets that provide at least a 4-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
 - 3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.
- C. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-607-B. Predrilling shall be with holes for use with lugs specified in this Section.
 - 1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
 - 2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
 - 3. Rack-Mounted Vertical Busbar: 72 or 36 inches long, with stainless-steel or copper-plated hardware for attachment to the rack.

2.5 GROUND RODS

- A. Refer to Section 26 05 26 "Grounding and Bonding for Electrical Systems" for ground rod requirements.

2.6 IDENTIFICATION

- A. Comply with requirements for identification products in Section 270553 "Identification for Communications Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.
- B. Inspect the test results of the ac grounding system measured at the point of BCT connection.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.
- B. Comply with NECA 1.
- C. Comply with TIA-607-B.

3.3 APPLICATION

- A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
 - 1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
 - 2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
- B. Underground Grounding Conductors: Install barecopper conductor, No. 2 AWG minimum.
- C. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.
- D. Conductor Support:

1. Secure grounding and bonding conductors at intervals of not less than 36 inches.

E. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
2. Install without splices.
3. Support at not more than 36-inch intervals.
4. Install grounding and bonding conductors in 3/4-inch PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.
 - a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 270528 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB.

3.4 GROUNDING ELECTRODE SYSTEM

- A. The BCT between the TMGB and the ac service equipment ground shall not be smaller than No. 3/0 AWG.

3.5 GROUNDING BUSBARS

- A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 4 inches minimum from wall, 12 inches above finished floor unless otherwise indicated.
- B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.6 CONNECTIONS

- A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.
- B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.
- C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
 1. Use crimping tool and the die specific to the connector.
 2. Pretwist the conductor.
 3. Apply an antioxidant compound to all bolted and compression connections.

- D. Primary Protector: Bond to the TMGB with insulated bonding conductor.
- E. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.
- F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.
- G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.
- H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.
- I. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA-568-C.1 and TIA-568-C.2 when grounding shielded balanced twisted-pair cables.
- J. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

3.7 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.
- B. Comply with IEEE C2 grounding requirements.
- C. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches extends above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

3.8 IDENTIFICATION

- A. Labels shall be preprinted or computer-printed type.
 - 1. Label TMGB(s) with "fs-TMGB," where "fs" is the telecommunications space identifier for the space containing the TMGB.
 - 2. Label TGB(s) with "fs-TGB," where "fs" is the telecommunications space identifier for the space containing the TGB.
 - 3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 - 2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.
 - a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.
 - 3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.
 - a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB and in each TGB. Maximum acceptable ac current level is 1 A.
- C. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.
- D. Grounding system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION 27 05 26

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SECTION 27 05 28

PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal conduits and fittings.
 - 2. Nonmetallic conduits and fittings.
 - 3. Optical-fiber-cable pathways and fittings.
 - 4. Metal wireways and auxiliary gutters.
 - 5. Nonmetallic wireways and auxiliary gutters.
 - 6. Metallic surface pathways.
 - 7. Nonmetallic surface pathways.
 - 8. Tele-power poles.
 - 9. Hooks.
 - 10. Boxes, enclosures, and cabinets.

1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid conduit.

1.4 ACTION SUBMITTALS

- A. Product data for the following:
 - 1. Wireways and fittings.
 - 2. Tele-power poles.
 - 3. Boxes, enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer.
- B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

- A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.
- B. 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. AFC Cable Systems, Inc.
 - 2. Allied Tube & Conduit.
 - 3. Anamet Electrical, Inc.
 - 4. Electri-Flex Company.
 - 5. O-Z/Gedney; a brand of EGS Electrical Group.
 - 6. Picoma Industries, a subsidiary of Mueller Water Products, Inc.
 - 7. Republic Conduit.
 - 8. Southwire Company.
 - 9. Thomas & Betts Corporation.
 - 10. Western Tube and Conduit Corporation.
 - 11. Wheatland Tube Company; a division of John Maneely Company.
- C. General Requirements for Metal Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
 - 2. Comply with TIA-569-D.
- D. GRC: Comply with ANSI C80.1 and UL 6.
- E. ARC: Comply with ANSI C80.5 and UL 6A.
- F. PVC-Coated Steel Conduit: PVC-coated GRC.
 - 1. Comply with NEMA RN 1.
 - 2. Coating Thickness: 0.040 inch, minimum.
- G. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.

2. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
 3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- H. Joint Compound for GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

- A. Description: Comply with UL 2024; flexible-type pathway with a circular cross section, approved for riser installation unless otherwise indicated.
- B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- C. Comply with TIA-569-D.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal trough of rectangular cross section fabricated to required size and shape, without holes or knockouts, and with hinged or removable covers.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Cooper B-Line, Inc.
 2. Hoffman; a Pentair company.
 3. Mono-Systems, Inc.
 4. Square D; a brand of Schneider Electric.
 5. Wiremold.
 6. Equity Industries.
- C. General Requirements for Metal Wireways and Auxiliary Gutters:
 1. Comply with UL 870 and NEMA 250, Type 4 unless otherwise indicated, and sized according to NFPA 70.
 2. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 3. Comply with TIA-569-D.
- D. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- E. Wireway Covers: Screw-cover type unless otherwise indicated.

- F. Finish: Manufacturer's standard enamel finish.

2.4 TELE-POWER POLES:

- A. Description: Prefabricated, finished metal pole with prewired power and communications outlets.
- B. Material: Galvanized steel with ivory baked-enamel finish.
- C. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.
- D. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- E. Comply with TIA-569-D.

2.5 HOOKS

- A. Description: Prefabricated sheet metal cable supports for telecommunications cable.
- B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- C. Comply with TIA-569-D.
- D. Galvanized steel.
- E. J shape.

2.6 BOXES, ENCLOSURES, AND CABINETS

- A. Description: Enclosures for communications.
- B. 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. Adalet.
 - 2. Cooper Technologies Company; Cooper Crouse-Hinds.
 - 3. EGS/Appleton Electric.
 - 4. Erickson Electrical Equipment Company.
 - 5. FSR Inc.
 - 6. Hoffman; a Pentair company.
 - 7. Hubbell Incorporated; Killark Division.
 - 8. Kraloy.
 - 9. Milbank Manufacturing Co.
 - 10. Mono-Systems, Inc.

11. O-Z/Gedney; a brand of EGS Electrical Group.
12. RACO; a Hubbell Company.
13. Spring City Electrical Manufacturing Company.
14. Thomas & Betts Corporation.
15. Wiremold / Legrand.

C. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-D.
2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
4. Device Box Dimensions: 4 inches square by 2-1/8 inches deep or 4 inches by 2-1/8 inches by 2-1/8 inches deep.
5. Gangable boxes are prohibited.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.

E. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

F. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

G. Floor boxes: Refer to Electrical specification 26 05 33 "Raceways and Boxes for Electrical Systems".

H. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 4, with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

I. Cabinets:

1. NEMA 250, Type 4 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

- A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
 - 1. Exposed Conduit: ARC.
 - 2. Concealed Conduit, Aboveground: ARC.
 - 3. Underground Conduit: Refer to Section 270543 "Underground Pathways and Structures for Communication Systems"
 - 4. Boxes and Enclosures, Aboveground: NEMA 250, Type 4.
- B. Indoors: Apply pathway products as specified below unless otherwise indicated:
 - 1. Horizontal Cabling: ARC.
 - 2. Exposed, Not Subject to Physical Damage: EMT.
 - 3. Exposed and Subject to Physical Damage: GRC. Pathway locations include the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - d. Sally port
 - 4. Concealed in Ceilings and Interior Walls and Partitions: EMT
 - 5. Above accessible ceiling: cable tray or j-hooks
 - 6. Boxes and Enclosures: NEMA 250, Type 4
- C. Minimum Pathway Size: 3/4-inch trade size for copper and aluminum cables, and 1 inch for optical-fiber cables.
- D. Pathway Fittings: Compatible with pathways and suitable for use and location.
 - 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 - 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.

3.2 INSTALLATION

- A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
 - 1. NECA 1.
 - 2. NECA/BICSI 568.

3. TIA-569-D.
 4. NECA 101
 5. NECA 102.
 6. NECA 105.
 7. NECA 111.
- B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- C. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- D. Comply with requirements in Section 270529 "Hangers and Supports for Communications Systems" for hangers and supports.
- E. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling" for sleeves and sleeve seals for communications.
- F. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- G. Complete pathway installation before starting conductor installation.
- H. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- I. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.
- J. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- K. Support conduit within 12 inches of enclosures to which attached.
- L. Pathways Embedded in Slabs:
1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot intervals.
 2. Arrange pathways to cross building expansion joints at right angles with expansion fittings. Comply with requirements for expansion joints specified in this article.
 3. Arrange pathways to keep a minimum of 2 inches of concrete cover in all directions.
 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
 5. Change from nonmetallic conduit and fittings to GRC and fittings before rising above floor.

- M. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
- N. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
- O. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
- P. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.
- Q. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.
- R. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- S. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.
 - 1. .
- T. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
 - 1. 3/4-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.
 - 2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
 - 3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- U. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway-sealing fittings according to NFPA 70.
- V. Install devices to seal pathway interiors at accessible locations. Locate seals, so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where an underground service pathway enters a building or structure.
 - 3. Where otherwise required by NFPA 70.

- W. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
- X. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet. Install in each run of aboveground ARC that is located where environmental temperature change may exceed 100 deg F, and that has straight-run length that exceeds 100 feet.
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- Y. Hooks:
1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
 2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
 3. Hook spacing shall allow no more than 6 inches of slack. The lowest point of the cables shall be no less than 6 inches adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
 4. Space hooks no more than 5 feet o.c.
 5. Provide a hook at each change in direction.
- Z. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to bottom of box unless otherwise indicated.
- AA. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to

provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

- BB. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
- CC. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- DD. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- EE. Set metal floor boxes level and flush with finished floor surface.
- FF. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.4 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 27 05 28

SECTION 27 05 29

HANGERS AND SUPPORTS FOR COMMUNICATIONS 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. Steel slotted support systems for communication raceways.
2. Aluminum slotted support systems for communication raceways.
3. Conduit and cable support devices.
4. Support for conductors in vertical conduit.
5. Structural steel for fabricated supports and restraints.
6. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
7. Fabricated metal equipment support assemblies.

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 the following:
 - a. Slotted support systems, hardware, and accessories.
 - b. Clamps.
 - c. Hangers.
 - d. Sockets.
 - e. Eye nuts.
 - f. Fasteners.
 - g. Anchors.
 - h. Saddles.
 - i. Brackets.

2. Include rated capacities and furnished specialties and accessories.

- B. Shop Drawings: For fabrication and installation details for communications hangers and support systems.

1. Trapeze hangers. Include product data for components.
2. Steel slotted-channel systems.
3. Aluminum slotted-channel systems.
4. Nonmetallic slotted-channel systems.
5. Equipment supports.
6. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
 1. AWS D1.1/D1.1M.
 2. AWS D1.2/D1.2M.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Flame Rating: Class 1.
 2. Self-extinguishing according to ASTM D635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- 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:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation; Kindorf.
 - f. Unistrut.
 - g. Wesanco, Inc.

- B. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.
1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 2. Material for Channel, Fittings, and Accessories: Galvanized steel.
 3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 4. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 6. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 7. Channel Dimensions: Selected for applicable load criteria.
- C. Aluminum Slotted Support Systems: Extruded aluminum channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.
1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 2. Channel Material: 6063-T6 aluminum alloy.
 3. Fittings and Accessories Material: 5052-H32 aluminum alloy.
 4. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 6. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 7. Channel Dimensions: Selected for applicable load criteria.
- D. Conduit and Cable Support Devices: Steel clamps, hangers, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored communications conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

2. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.
6. Toggle Bolts: [**All-steel**] [**Stainless-steel**] springhead type.
7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 1. NECA 1.
 2. NECA/BICSI 568.
 3. TIA-569-D.
 4. NECA 101.
 5. NECA 102.
 6. NECA 105.
 7. NECA 111.
- B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with single-bolt conduit clamps, using spring friction action for retention in support channel.
- F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Raceway Support Methods: In addition to methods described in NECA 1, raceway may be supported by openings through structure members, according to NFPA 70.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten communications items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Use approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Use expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated-driven threaded studs, provided with lock washers and nuts, may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 - 6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor communications materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Section 09 09 00 "Painting and Coating" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 27 05 29

SECTION 27 05 36

CABLE TRAYS FOR COMMUNICATIONS 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. Ladder cable tray.
 - 2. Wire-mesh cable tray
 - 3. Cable tray accessories.
 - 4. Warning signs.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of cable tray.
 - 1. Include data indicating dimensions and finishes for each type of cable tray indicated.
- B. Shop Drawings: For each type of cable tray.
 - 1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
 - 2. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
 - a. Vertical and horizontal offsets and transitions.
 - b. Clearances for access above and to sides of cable trays.
 - c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
 - d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

- A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
 - 1. Source Limitations: Obtain cable trays and components from single manufacturer.
- B. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:
 - 1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
 - 2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
 - 3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 LADDER CABLE TRAY

- A. Description:
 - 1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
 - 2. Width: 12 inches unless otherwise indicated on Drawings.
 - 3. Minimum Usable Load Depth: 4 inches.
 - 4. Straight Section Lengths: 10 feet, except where shorter lengths are required to facilitate tray assembly.
 - 5. Rung Spacing: 6 inches o.c.
 - 6. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.
 - 7. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.
 - 8. No portion of the rungs shall protrude below the bottom plane of side rails.
 - 9. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
 - 10. Fitting Minimum Radius: 24 inches.

11. Class Designation: Comply with NEMA VE 1, Class 12A.
12. Splicing Assemblies: Bolted type using serrated flange locknuts.
13. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
14. Covers: Ventilated-hat type made of same materials and with same finishes as cable tray.

B. Materials and Finishes:

1. Aluminum:
 - a. Materials: Alloy 6063-T6 according to ANSI H35.1/H 35.1M for extruded components, and Alloy 5052-H32 or Alloy 6061-T6 according to ANSI H35.1/H 35.1M for fabricated parts.
 - b. Hardware: Stainless steel, Type 316, ASTM F593 and ASTM F594.
 - c. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F593 and ASTM F594.

2.4 WIRE-MESH CABLE TRAY

A. Description:

1. Configuration: Galvanized- steel wire mesh, complying with NEMA VE 1.
2. Width: 12 inches unless otherwise indicated on Drawings.
3. Minimum Usable Load Depth: 4 inches.
4. Straight Section Lengths: 10 feet, except where shorter lengths are required to facilitate tray assembly.
5. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
6. Class Designation: Comply with NEMA VE 1, Class 12A.
7. Splicing Assemblies: Bolted type using serrated flange locknuts.
8. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

B. Materials and Finishes:

1. Steel:
 - a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of ASTM A1011/A1011M, SS, Grade 33.
 - b. Steel Tray Splice Plates: ASTM A1011/A1011M, HSLAS, Grade 50, Class 1.
 - c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A510/A510M, Grade 1008.
 - d. Finish: Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware according to ASTM F1136.

2.5 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Barrier Strips: Same materials and finishes as for cable tray.
- C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.6 WARNING SIGNS

- A. Comply with requirements for identification in Section 270553 "Identification for Communications Systems."
- B. Lettering: 1-1/2-inch-high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

2.7 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect cable trays according to NEMA VE 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

- A. Install cable trays according to NEMA VE 2.
- B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
- C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
- D. Remove burrs and sharp edges from cable trays.
- E. Join aluminum cable tray with splice plates; use four square neck-carriage bolts and locknuts.
- F. Fasten cable tray supports to building structure.
- G. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
- H. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.

- I. Support bus assembly to prevent twisting from eccentric loading.
- J. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.
- K. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.
- L. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.
- M. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.
- N. Make changes in direction and elevation using manufacturer's recommended fittings.
- O. Make cable tray connections using manufacturer's recommended fittings.
- P. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
- Q. Install cable trays with enough workspace to permit access for installing cables.
- R. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.
- S. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.
- T. Clamp covers on cable trays installed outdoors with heavy-duty clamps.
- U. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."
- B. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."

- D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.
- E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

- A. Install cables only when each cable tray run has been completed and inspected.
- B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.
- C. Fasten cables on vertical runs to cable trays every 18 inches.
- D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.
- E. Tie MI cables down every 36 inches where required to provide a 2-hour fire rating and every 72 inches elsewhere.

3.4 CONNECTIONS

- A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.
- B. Connect pathways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
 - 2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
 - 3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.

4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorquing in suspect areas.
7. Check for improperly sized or installed bonding jumpers.
8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 27 05 36

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SECTION 27 05 43

UNDERGROUND PATHWAYS AND STRUCTURES FOR COMMUNICATION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal conduit and fittings, including GRC and PVC-coated GRC.
 - 2. Rigid nonmetallic duct.
 - 3. Duct accessories, including rigid innerduct and fabric innerduct.

1.3 DEFINITIONS

- A. Direct-Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials, such as concrete.
- B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.
- C. Duct Bank:
 - 1. Two or more ducts installed in parallel, with or without additional casing materials.
 - 2. Multiple duct banks.
- D. GRC: Galvanized rigid conduit.
- E. IMC: Intermediate metal conduit.
- F. RNC: Rigid nonmetallic conduit.
- G. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 ACTION SUBMITTALS

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

1. Include duct-bank materials, including spacers and miscellaneous components.
2. Include duct and conduits and their accessories, including elbows, end bells, bends, fittings, duct spacers and solvent cement.
3. Include underground-line warning tape.

1.5 INFORMATIONAL SUBMITTALS

- A. Duct and Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
 1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
 2. Drawings shall be signed and sealed by a qualified professional engineer.
- B. Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.
- C. Source quality-control reports.
- D. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

1.7 FIELD CONDITIONS

- A. Interruption of Existing Communications Service: Do not interrupt communications service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary communications service according to requirements indicated:
 1. Notify Construction Manager no fewer than two weeks in advance of proposed interruption of communications service.
 2. Do not proceed with interruption of communications service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 RIGID NONMETALLIC DUCTS

- 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. ARNCO Corp.
 2. Beck Manufacturing.

3. Cantex, Inc.
4. CertainTeed Corp.; Pipe & Plastics Group.
5. Champion Fiberglass.
6. Condux International, Inc.
7. ElecSys, Inc.
8. Electri-Flex Company.
9. IPEX Inc.
10. Lamson & Sessions; Carlon Electrical Products.
11. Manhattan/CDT; a division of Cable Design Technologies.
12. Spiraduct/AFC Cable Systems, Inc.
13. United Fiberglass of America
14. TE Connectivity / Raychem

- B. Underground Plastic Utilities Duct: Type EPC-80-PVC and Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.
- C. General Requirements for Nonmetallic Ducts and Fittings:
1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
 2. Comply with TIA-569-C and TIA-758-C.
- D. Solvents and Adhesives: As recommended by duct manufacturer.

2.2 FLEXIBLE NONMETALLIC DUCTS

- A. HDPE Duct: Type EPEC 40-HDPE and Type EPEC 80-HDPE complying with NEMA TC 7 and UL 651A.
1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
 2. Comply with TIA-569-C and TIA-758-C.

2.3 DUCT ACCESSORIES

- A. Rigid Innerduct: Smooth HDPE duct, orange in color, designed for installation within a duct or pathway.
- B. Fabric Innerduct: Continuous, polyester, multi -pocket fabric innerduct, with internal pull tape and tracer wire.
- C. Duct Spacers: Factory-fabricated rigid PVC interlocking spacers, sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.
- D. Underground-Line Warning Tape: Underground-line warning tape specified in Section 270553 "Identification for Communications Systems."

2.4 PRECAST CONCRETE HANDHOLES AND BOXES

- A. Description: Monolithically poured, factory-fabricated, reinforced-concrete walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
- B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. ARNCO Corp.
 - 2. Beck Manufacturing.
 - 3. Cantex, Inc.
 - 4. CertainTeed Corp.; Pipe & Plastics Group.
 - 5. Champion Fiberglass.
 - 6. Condux International, Inc.
 - 7. ElecSys, Inc.
 - 8. Electri-Flex Company.
 - 9. IPEX Inc.
 - 10. Lamson & Sessions; Carlon Electrical Products.
 - 11. Manhattan/CDT; a division of Cable Design Technologies.
 - 12. Spiraduct/AFC Cable Systems, Inc.
 - 13. United Fiberglass of America
 - 14. TE Connectivity / Raychem
- C. Comply with ASTM C858 for design and manufacturing processes.
- D. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
- E. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- F. Cover Legend: Molded lettering, "COMMUNICATIONS."
- G. Configuration: Units shall be designed for flush burial and have open closed bottom unless otherwise indicated.
- H. Extensions and Slabs: Designed to mate with bottom of enclosure, and made of same material as enclosure.
 - 1. Extension shall provide increased depth of 12 inches.
 - 2. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
- I. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
- J. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct and duct banks, plus an additional 6 inches vertically and horizontally to accommodate alignment variations.

1. Knockout panels shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
 2. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 3. Knockout panel openings shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
 4. Knockout panels shall be 1-1/2 to 2 inches thick.
- K. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
1. Type and size shall match fittings to duct or conduit to be terminated.
 2. Fittings shall align with elevations of approaching duct and be located near interior corners of handholes to facilitate racking of cable.
- L. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
- 2.5 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER
- A. Description: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
 - B. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
 - C. Color: Gray.
 - D. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
 - E. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 - F. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - G. Cover Legend: Molded lettering, "COMMUNICATIONS."
 - H. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
 - I. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
 - J. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.6 FIBERGLASS HANDHOLES AND BOXES WITH POLYMER CONCRETE FRAME AND COVER

- A. Description: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.
- B. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
- C. Color: Gray.
- D. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
- E. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- F. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- G. Cover Legend: Molded lettering, "COMMUNICATIONS."
- H. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
- I. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
- J. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.7 HIGH-DENSITY PLASTIC BOXES

- A. Description: Injection molded of high-density polyethylene or copolymer-polypropylene. Cover shall be made of polymer concrete.
- B. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
- C. Color: Gray.
- D. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
- E. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- F. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- G. Cover Legend: Molded lettering, "COMMUNICATIONS."

- H. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
- I. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
- J. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.8 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C1037.
- B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 - 1. Tests of materials shall be performed by an independent testing agency.
 - 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 - 3. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.
- C. Clear and grub vegetation to be removed, and protect vegetation to remain according to Section 311000 "Site Clearing." Remove and stockpile topsoil for reapplication according to Section 311000 "Site Clearing."

3.2 UNDERGROUND DUCT APPLICATION

- A. Duct for Communications Direct Buried: Type EPC-40-PVC RNC, in direct-buried duct bank unless otherwise indicated.

- B. Duct for Communications Direct-Bored: Type EPEC-40-HDPE duct in direct-bored duct bank unless otherwise indicated.
- C. Underground Duct Crossing Roadways: Type EPC-40-PVC RNC, encased in reinforced concrete.
- D. Stub-Ups for Communications: Concrete-encased GRC.

3.3 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for Communications:
 - 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
 - 3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer concrete units, SCTE 77, Tier 8 structural load rating.
 - 4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.
 - 5. Cover design load shall not exceed the design load of the handhole or box.

3.4 EARTHWORK

- A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

3.5 DUCT AND DUCT-BANK INSTALLATION

- A. Where indicated on Drawings, install duct, spacers, and accessories into the duct configuration shown. Duct installation requirements in this Section also apply to duct bank.
- B. Install duct and duct bank according to NEMA TCB 2 and TIA-758-C.
- C. Slope: Pitch duct and duct bank a minimum slope of 1:100 down toward manholes and handholes and away from buildings and equipment. Slope duct and duct bank from a high point in runs between two manholes, to drain in both directions.
- D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations unless otherwise indicated.
 - 1. Duct and duct banks shall have maximum of two 90-degree bends, or the total of all bends shall be no more 180 degrees between pull points.

- E. Joints: Use solvent-cemented joints in duct and fittings, and make watertight according to manufacturer's written instructions. Stagger couplings, so those of adjacent ducts do not lie in same plane.
- F. End-Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 6 inches o.c. for 4-inch duct, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct slope and without forming a trap in the line.
 - 2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight-line direct-buried duct and duct banks, with calculated expansion of more than 3/4 inch.
 - 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- G. Terminator Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches o.c. for 4-inch duct, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to terminator spacing 10 feet from the terminator without reducing duct slope and without forming a trap in the line.
 - 2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight-line duct or duct bank, with calculated expansion of more than 3/4 inch.
- H. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet outside the building wall, without reducing duct slope away from the building or forming a trap in the duct. Use fittings manufactured for RNC duct-to-GRC conduit transition. Install GRC penetrations of building walls as specified in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."
- I. Sealing: Provide temporary closure at terminations of duct that has cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- J. Innerduct: Install immediately after mandreling duct. Size and type as indicated on Drawings.
- K. Pulling Cord: Install 200-lbf-test nylon cord in empty duct and innerduct.
- L. Concrete-Encased Duct and Duct Bank:
 - 1. Excavate trench bottom to provide firm and uniform support for duct or duct bank. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes less than 6 inches in nominal diameter.
 - 2. Width: Excavate trench 12 inches wider than duct or duct bank on each side.

3. Depth: Install top of duct and duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
4. Support duct and duct bank on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
5. Minimum Space Between Duct: 3 inches between edge of duct and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and communications ducts.
6. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than five spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around duct or duct bank.
7. Elbows: Use manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct run unless otherwise indicated. Extend concrete encasement throughout length of elbow.
8. Elbows: Use manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct run.
 - a. Couple GRC to duct with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. Stub-Ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups shall be minimum 4 inches above finished floor and minimum 3 inches from conduit side to edge of slab.
 - c. Stub-Ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups shall be minimum 4 inches above finished floor and no less than 3 inches from conduit side to edge of wall.
9. Reinforcement: Reinforce concrete-encased duct and duct bank where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
10. Forms: Use trench walls to form side walls of duct and duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
11. Concrete Cover: Install a minimum of 3 inches of concrete cover between edge of duct to exterior envelope wall, 2 inches between ducts, and 4 inches between power and communications duct.
12. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of duct as its temperature changes during and after the pour.

Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.

- b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing-rod dowels extending a minimum of 18 inches into concrete on both sides of joint near corners of envelope.
13. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between ducts and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto duct. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

M. Direct-Buried Duct and Duct Banks:

1. Excavate trench bottom to provide firm and uniform support for duct and duct bank. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for duct less than 6 inches in nominal diameter.
2. Install duct with a minimum of 3 inches between duct for like services and 6 inches between power and signal duct.
3. Width: Excavate trench 12 inches wider than duct or duct bank on each side.
4. Depth: Install top of duct or duct bank at least 36 inches below finished grade unless otherwise indicated.
5. Set elevation of bottom of duct or duct bank below frost line.
6. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
7. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around duct or duct bank.
8. Elbows: Install manufactured duct elbows for stub-ups, at building entrances through floor, and at changes of direction in duct unless otherwise indicated. Encase elbows for stub-ups throughout length of elbow..
9. Install manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct.
 - a. Couple GRC to duct with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. For equipment mounted on outdoor bases, extend GRC horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
10. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving duct at end of run free to move with expansion and contraction, as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over

duct and hand tamp. Firmly tamp backfill around duct to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.

- a. Place minimum of 3 inches of sand as a bed for duct and duct bank. Place sand to a minimum of 6 inches above top level of duct and duct bank.
- b. Place minimum of 6 inches of engineered fill above concrete encasement of duct bank.

- N. Underground-Line Warning Tape: Bury conducting underground-line warning tape specified in Section 270553 "Identification for Communication Systems" no less than 12 inches above all concrete-encased duct and duct bank and approximately 12 inches below grade. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.6 INSTALLATION OF CONCRETE HANDHOLES AND BOXES

A. Precast Concrete Handhole Installation:

1. Comply with ASTM C891 unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:

1. Install handholes with bottom below frost line below grade.
2. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
3. Where indicated, cast handhole cover frame integrally with handhole structure.

- C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

- D. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Section 071113 "Bituminous Dampproofing." After duct has been connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.

- E. Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.

- F. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
- G. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for field-installed anchor bolts installed. Use a minimum of two anchors for each cable stanchion.

3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct and duct bank, and seal joint between box and extension as recommended by manufacturer.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch above finished grade.
- D. Install handholes and boxes with bottom below frost line below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
- F. Field cut openings for duct according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring, encircling, and in contact with, enclosure, and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
 - 1. Concrete: 3000 psi, 28-day strength, complying with Section 033000 "Cast-in-Place Concrete," with a troweled finish.

3.8 GROUNDING

- A. Ground underground duct, duct bank, and utility structures according to Section 270526 "Grounding and Bonding for Communications Systems."

3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:

1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch-long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.
3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 270526 "Grounding and Bonding for Communications Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.10 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris.
- B. Clean internal surfaces of manholes, including sump.
 1. Sweep floor, removing dirt and debris.
 2. Remove foreign material.

END OF SECTION 27 05 43

SECTION 27 05 44

SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Round sleeves.
 - 2. Rectangular sleeves.
 - 3. Sleeve seal systems.
 - 4. Grout.
 - 5. Pourable sealants.
 - 6. Foam sealants.

- B. Related Requirements:

- 1. Section 07 84 13 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ROUND SLEEVES

- A. Wall Sleeves, Steel:

- 1. Description: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.

- B. Wall Sleeves, Cast Iron:

1. Description: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop.
- C. Pipe Sleeves, PVC:
 1. Description: ASTM D1785, Schedule 40.
- D. Molded Sleeves, PVC:
 1. Description: With nailing flange for attaching to wooden forms.
- E. Molded Sleeves, PE or PP:
 1. Description: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- F. Sheet Metal Sleeves, Galvanized Steel, Round:
 1. Description: Galvanized-steel sheet; thickness not less than 0.0239-inch; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

2.2 RECTANGULAR SLEEVES

- A. Sheet Metal Sleeves, Galvanized Steel, Rectangular:
 1. Description:
 - a. Material: Galvanized sheet steel.
 - b. Minimum Metal Thickness:
 - 1) For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness must be 0.052 inch.
 - 2) For sleeve cross-section rectangle perimeter not less than 50 inches or with one or more sides larger than 16 inches, thickness must be 0.138 inch.

2.3 SLEEVE SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable or between pathway and cable.
 1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 2. Pressure Plates: Fiber-reinforced plastic Stainless steel.
 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.4 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
 - 1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

2.5 POURABLE SEALANTS

- A. Description: Single-component, neutral-curing elastomeric sealants of grade indicated below.
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

2.6 FOAM SEALANTS

- A. to produce a flexible, nonshrinking foam. Foam expansion must not damage cables or crack penetrated structure.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - b. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and pathway or cable, unless sleeve seal system is to be installed.

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
- C. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:
1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 2. Seal space outside of sleeves with approved joint compound for wall assemblies.
- D. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- E. Aboveground, Exterior-Wall Penetrations: Seal penetrations using [steel] [cast-iron] pipe sleeves and mechanical sleeve seal systems. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- F. Underground, Exterior-Wall and Floor Penetrations:
1. Install steel pipe sleeves with integral waterstops. Size sleeves to allow for 1-inch annular clear space between pathway or cable and sleeve for installing sleeve seal system. Install sleeve during construction of floor or wall.
 2. Install steel pipe sleeves. Size sleeves to allow for 1-inch annular clear space between pathway or cable and sleeve for installing sleeve seal system. Grout sleeve into wall or floor opening.

3.2 INSTALLATION OF RECTANGULAR SLEEVES AND SLEEVE SEALS

- A. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.
- B. Install conduits and cable with no crossings within the sleeve.
- C. Fill opening around conduits and cables with expanding foam without leaving voids.
- D. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

3.3 INSTALLATION OF SLEEVE SEAL SYSTEMS

- A. Install sleeve seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or

cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

END OF SECTION 27 05 44

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SECTION 27 05 53

IDENTIFICATION FOR COMMUNICATIONS 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. Underground-line warning tape.
 - 2. Signs.
 - 3. Bands and tubes.
 - 4. Cable ties.
 - 5. Miscellaneous identification products.
 - 6. Labels.

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 communications identification products.
- B. Identification Schedule:
 - 1. Outlets: Scaled drawings indicating location and proposed designation.
 - 2. Backbone Cabling: Riser diagram showing each communications room, backbone cable, and proposed backbone cable designation.
 - 3. Racks: Scaled drawings indicating location and proposed designation.
 - 4. Patch Panels: Enlarged scaled drawings showing rack row, number, and proposed designations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 70 and TIA 606-B.

- B. Comply with ANSI Z535.4 for safety signs and labels.
- C. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Equipment Identification Labels:
 - 1. Black letters on a white field.

2.3 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
- B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters of raceway or cable they identify, that stay in place by gripping action.
- C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-thick, polyester flexible labels with acrylic pressure-sensitive adhesive.
 - 1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating protective shields over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
 - 2. Marker for Labels:
 - a. Machine-printed, permanent, waterproof black ink recommended by printer manufacturer.
- D. Self-Adhesive Labels: Polyester, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
 - 1. Minimum Nominal Size:
 - a. 1-1/2 by 6 inches for raceway and conductors.
 - b. 3-1/2 by 5 inches for equipment.
 - c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

- A. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters of raceway or cable they identify, that stay in place by gripping action.

2.5 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, and ANSI Z535.4.
2. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL-FIBER CABLE"

C. Tag, Detectable

1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Width: 3 inches.
3. Overall Thickness: 5 mils.
4. Foil Core Thickness: 0.35 mil.
5. Weight: 28 lb/1000 sq. ft..
6. Tensile according to ASTM D882: 70 lbf and 4600 psi.

2.6 SIGNS

A. Baked-Enamel Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal Size: 7 by 10 inches.

B. Metal-Backed Butyrate Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal Size: 10 by 14 inches.

C. Laminated-Acrylic or Melamine-Plastic Signs:

1. Engraved legend.
2. Thickness:
 - a. For signs up to 20 sq. in., minimum 1/16 inch thick.
 - b. For signs larger than 20 sq. in., 1/8 inch thick.
 - c. Engraved legend with black letters on white face.
 - d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.7 CABLE TIES

- A. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
1. Minimum Width: 3/16 inch.
 2. Tensile Strength at 73 deg F according to ASTM D638: 7000 psi.
 3. UL 94 Flame Rating: 94V-0.
 4. Temperature Range: Minus 50 to plus 284 deg F.
 5. Color: Black.

2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying communications identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of communications systems and connected items.
- G. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- H. Vinyl Wraparound Labels:
 - 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
 - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
 - 3. Provide label 6 inches from cable end.
- I. Snap-Around Labels:
 - 1. Secure tight to surface at a location with high visibility and accessibility.
 - 2. Provide label 6 inches from cable end.
- J. Self-Adhesive Wraparound Labels:
 - 1. Secure tight to surface at a location with high visibility and accessibility.
 - 2. Provide label 6 inches from cable end.
- K. Self-Adhesive Labels:
 - 1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
 - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
- L. Snap-Around, Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.
- M. Underground-Line Warning Tape:

1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
2. Install underground-line warning tape for direct-buried cables and cables in raceways.

N. Cable Ties: General purpose, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations with high visibility. Identify by system and circuit designation.
- C. Accessible Fittings for Raceways and Cables within Buildings: Identify covers of each junction and pull box with self-adhesive labels containing wiring system legend.
 1. System legends shall be as follows:
 - a. Telecommunications.
- D. Faceplates: Label individual faceplates with self-adhesive labels. Place label at top of faceplate. Each faceplate shall be labeled with its individual, sequential designation, composed of the following, in the order listed:
 1. Wiring closet designation.
 2. Colon.
 3. Faceplate number.
- E. Equipment Room Labeling:
 1. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels containing equipment designation.
 2. Patch Panels: Label individual rows in each rack, starting at top and working down, with self-adhesive labels.
 3. Data Outlets: Label each outlet with a self-adhesive label indicating the following, in the order listed:
 - a. Room number being served.
 - b. Colon.
 - c. Faceplate number.

- F. Backbone Cables: Label each cable with a self-adhesive wraparound label indicating the location of the far or other end of the backbone cable. Patch panel or punch down block where cable is terminated should be labeled identically.
- G. Horizontal Cables: Label each cable with a self-adhesive wraparound label indicating the following, in the order listed:
 - 1. Room number.
 - 2. Colon.
 - 3. Faceplate number.
- H. Locations of Underground Lines: Underground-line warning tape for copper, coaxial, hybrid copper/fiber, and optical-fiber cable.
- I. Instructional Signs: Self-adhesive labels.
- J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures: Baked-enamel warning signs.
 - 1. Apply to exterior of door, cover, or other access.
- K. Equipment Identification Labels:
 - 1. Indoor Equipment: Baked-enamel signs.
 - 2. Outdoor Equipment: Laminated-acrylic or melamine-plastic sign.
 - 3. Equipment to Be Labeled:
 - a. Equipment racks and cabinets
 - b. Patch panels
 - c. Communications cabinets.
 - d. Uninterruptible power supplies.
 - e. Computer room air conditioners.
 - f. Fire-alarm and suppression equipment.
 - g. Power distribution components.

END OF SECTION 27 05 53

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SECTION 27 11 00

COMMUNICATIONS EQUIPMENT ROOM FITTINGS

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. Backboards.
 - 2. Boxes, enclosures, and cabinets.

1.3 DEFINITIONS

- A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.
- B. BICSI: Building Industry Consulting Service International.
- C. RCDD: Registered communications distribution designer.
- D. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.
- E. TGB: Telecommunications grounding bus bar.
- F. TMGB: Telecommunications main grounding bus bar.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.
 1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD.
 2. Installation Supervision: Installation shall be under direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
 3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, A/C grade, 3/4" by 48" by 96".
- B. Backboard Paint: All plywood backboards are to be mounted smooth side out and painted with white fire retardant paint at time of installation and prior to installation of equipment onto the plywood.

2.3 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets shall be listed and labeled for intended location and use.
- B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, Type FD, aluminum, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- F. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- G. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- H. Device Box Dimensions: 4 inches square by 2-1/8 inches deep or 4 inches by 2-1/8 inches by 2-1/8 inches deep.
- I. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 4 with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- J. Cabinets:
 - 1. NEMA 250, Type 3R galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.
 - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

- A. Comply with requirements in Section 270528 "Pathways for Communications Systems" for materials and installation requirements for underground pathways.

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI's "Telecommunications Distribution Methods Manual" for layout of communications equipment spaces.

- C. Comply with BICSI's "Information Technology Systems Installation Methods Manual" for installation of equipment in communications equipment spaces.
- D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- E. Coordinate layout and installation of communications equipment in tracks and in room.
 - 1. Meet jointly with systems providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
 - 2. Record agreements reached in meetings and distribute them to other participants.
 - 3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize configurations and space requirements of communications equipment.
 - 4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.
- F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.
- G. Backboards:
 - 1. Install from 6 inches to 8 feet, 6 inches above finished floor. If plywood is fire rated, ensure that fire-rating stamp is visible after installation.
 - 2. Paint all sides of backboard with two coats of paint.
 - 3. Comply with requirements for backboard installation in BICSI's "Information Technology Systems Installation Methods Manual" and TIA-569-D.

3.3 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.4 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with BICSI's "Information Technology Systems Installation Methods Manual," "Firestopping Practices" Ch.

END OF SECTION 27 11 00

SECTION 27 11 16

COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES

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. 19-inch equipment racks.
 - 2. 19-inch freestanding equipment cabinets.
 - 3. Power strips.
 - 4. Grounding.
 - 5. Labeling.

1.3 DEFINITIONS

- A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.
- B. BICSI: Building Industry Consulting Service International.
- C. LAN: Local area network.
- D. RCDD: Registered communications distribution designer.
- E. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.
- F. TGB: Telecommunications grounding bus bar.
- G. TMGB: Telecommunications main grounding bus bar.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.

2. Include rated capacities, operating characteristics, electrical characteristics, certifications, standards compliance, and furnished specialties and accessories.
- B. Shop Drawings: For communications racks, frames, and enclosures. Include plans, elevations, sections, details, and attachments to other work.
 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
 3. Grounding: Indicate location of TGB and its mounting detail showing standoff insulators and wall-mounting brackets.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.
 1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD.
 2. Installation Supervision: Installation shall be under direct supervision of Installer 2, Copper or Fiber, who shall be present at all times when Work of this Section is performed at Project site.
 3. Field Inspector: Currently registered by BICSI as RCDD to perform on-site inspection.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. UL listed.
- B. RoHS compliant.

2.2 19-INCH EQUIPMENT RACKS

- A. Description: Four- post racks with threaded rails designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting with an opening of 17.72-inches between rails.
- B. General Requirements:

1. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Material: Extruded aluminum.
3. Finish: Manufacturer's standard, baked-polyester powder coat.
4. Color: Black.

C. Floor-Mounted Racks:

1. Overall Height: 84 inches.
2. Overall Depth: 23 inches.
3. Four-Post Load Rating: 1000 lb.
4. Number of Rack Units per Rack: 42 minimum.
5. Threads: Universal square.
6. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug.
7. Base shall have a minimum of four mounting holes for permanent attachment to floor.
8. Top shall have provisions for attaching to cable tray or ceiling.
9. Self-leveling.

D. Horizontal Cable Management:

1. Manufacturers:
 - a. Hubbell HM24C
 - b. Or approved equal by Ortronics, Systimax.
2. Horizontal managers shall be 16ga. Cold rolled steel construction with (6) pass thru holes, and (7) Front mounted 3.5" steel rod D-Rings.
3. Baked-polyester powder coat finish.
4. Provide horizontal crossover cable manager as indicated on the plans, with a minimum height of two rack units each.

E. Vertical Cable Management:

1. Manufacturers:
 - a. Hubbell VM1013
 - b. Or approved equal by Ortronics, Systimax.
2. Vertical cable managers shall feature a steel rod construction for increased air flow.
3. Vertical cable managers shall feature a solid aluminum door that is designed to open left or right and swing out of way for cable management.
4. Vertical cable managers shall feature power strip mounting brackets on rear of manager.
5. Vertical cable manager shall accept and include (16) 3" black cable management spools.
6. Baked-polyester powder coat finish.

2.3 19-INCH EQUIPMENT CABINETS

- A. Description: Manufacturer-assembled four-post frame enclosed by side and top panels and front and rear doors, designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting with an opening of 17.72 inches between rails.
- B. General Cabinet Requirements:
 - 1. Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
 - 2. Material: Extruded aluminum.
 - 3. Finish: Manufacturer's standard, baked-polyester powder coat.
 - 4. Color: Black.
- C. Modular Freestanding Cabinets:
 - 1. Overall Height: 84 inches.
 - 2. Overall Depth: 23 inches.
 - 3. Load Rating: 3000 lb.
 - 4. Number of Rack Units: 42 minimum.
 - a. Numbering: Every rack units, on interior of rack.
 - 5. Threads: Universal square.
 - 6. Removable and lockable side and top panels.
 - 7. Hinged and lockable front and rear doors.
 - 8. Adjustable feet for leveling.
 - 9. Screened ventilation openings in roof and rear door.
 - 10. Cable access provisions in roof and base.
 - 11. TGB.
 - 12. Roof-mounted, 550-cfm fan with filter.
 - 13. Power strip.
 - 14. All cabinets keyed alike.
- D. Cable Management:
 - 1. Metal, with integral wire retaining fingers.
 - 2. Baked-polyester powder coat finish.
 - 3. Vertical cable management panels shall have front and rear channels, with covers.
 - 4. Provide horizontal crossover cable manager at top of each relay rack, with a minimum height of two rack units each.

2.4 POWER STRIPS

- A. Power Strips: Comply with UL 1363.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Rack mounting.
3. 10 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
4. LED indicator lights for power and protection status.
5. LED indicator lights for reverse polarity and open outlet ground.
6. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
7. Cord connected with 15-foot line cord.
8. Rocker-type on-off switch, illuminated when in on position.
9. Peak Single-Impulse Surge Current Rating: 26 kA per phase.
10. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all three modes shall be not more than 330 V.

2.5 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Rack and Cabinet TGBs: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-606-B. Predrilling shall be with holes for use with lugs specified in this Section.
 1. Cabinet-Mounted TGB: Terminal block, with stainless-steel or copper-plated hardware for attachment to cabinet.
 2. Rack-Mounted Horizontal TGB: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
 3. Rack-Mounted Vertical TGB: 72 or 36 inches long, with stainless-steel or copper-plated hardware for attachment to rack.

2.6 LABELING

- A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI TDMM for layout of communications equipment spaces.
- C. Comply with BICSI ITSIMM for installation of communications equipment spaces.
- D. All racks are to be bolted to each other as well as to the slab or wall.

- E. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- F. Coordinate layout and installation of communications equipment in racks and room.
 - 1. Meet jointly with system providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
 - 2. Record agreements reached in meetings and distribute them to other participants.
 - 3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment spaces to accommodate and optimize configuration and space requirements of telecommunications equipment.
 - 4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.
- G. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.2 GROUNDING

- A. Comply with NECA/BICSI 607.
- B. Install grounding according to BICSI ITSIMM, "Bonding, Grounding (Earthing) and Electrical Protection" Ch.
- C. Locate TGB to minimize length of bonding conductors. Fasten to wall, allowing at least 2 inches of clearance behind TGB. Connect TGB with a minimum No. 4 AWG grounding electrode conductor from TGB to suitable electrical building ground. Connect rack TGB to near TGB or the TMGB.
 - 1. Bond the shield of shielded cable to patch panel, and bond patch panel to TGB or TMGB.

3.3 IDENTIFICATION

- A. Coordinate system components, wiring, and cabling complying with TIA-606-B. Comply with requirements in Section 270553 "Identification for Electrical Systems."
- B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
- C. Labels shall be machine printed. Type shall be 3/16 inch in height.

END OF SECTION 27 11 16

SECTION 27 13 23

COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Types OFN and OFNG optical fiber cable.
 - 2. Optical fiber cable connecting hardware, patch panels, and cross-connects.
- B. Fiber backbone cabling from Courthouse to Garage to be provided under Courthouse Package. Fiber termination cabinets to be provided under this package.

1.2 DEFINITIONS

- A. Conductive Cable: Cable containing non-current-carrying electrically-conductive members such as metallic strength members and metallic vapor barriers.
- B. Cross-Connect: A facility enabling termination of cable elements and their interconnection or cross-connection.
- C. Types OFN and OFNG: Nonconductive cable for general purpose use.

1.3 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

1.4 ACTION SUBMITTALS

- A. Product Data:
 - 1. For each type of product.
- B. Shop Drawings:
 - 1. Cross-Connect and Patch-Panel Drawings: Detail mounting assemblies and show elevations and physical relationship between installed components.
- C. Certificates:
 - 1. For each type of product.

D. Field Quality-Control Submittals:

1. Optical fiber cable testing plan.
2. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Source Quality-Control Submittals:

1. Source quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For optical fiber cable, splices, and connectors.

B. Maintenance Contracts:

1. Software service agreement.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet-work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during remainder of construction period.

B. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine continuity of strand end to end. Use optical fiber flashlight or optical loss test set.
2. Test optical fiber cable while on reels. Use optical time domain reflectometer to verify cable length and locate cable defects, splices, and connector, including loss value of each. Retain test data and include record in maintenance data.

PART 2 - PRODUCTS

2.1 TYPES OFN AND OFNG OPTICAL FIBER CABLE

A. Description: This category covers jacketed optical fiber cable for general use within buildings in accordance with Article 770 of NFPA 70 containing no electrically conductive materials.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria: UL CCN QAYK; including UL 1651.
3. General Characteristics:
 - a. Performance: TIA-568.3.
 - b. Inside Plant Mechanical Properties: ICEA S-83-596.
 - c. Inside-Outside Plant Mechanical Properties: ICEA S-104-696.
 - d. Jacket:
 - 1) Cable cordage jacket, fiber, unit, and group color in accordance with TIA-598.
 - 2) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inch.

C. Types OFNR, Designation OM4, Multimode Optical Fiber Cable

1. Source Limitations: Obtain products from single manufacturer.
2. Additional Characteristics:
 - a. Construction: TIA-492AAAD; 850 nm laser-optimized, 50 μ m core diameter, 125 μ m cladding diameter.
 - b. Minimum Overfilled Modal Bandwidth-Length Product: 3500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
 - c. Minimum Effective Modal Bandwidth-Length Product: 4700 MHz-km at 850 nm wavelength.
3. Configuration: 12-fiber, tight buffer, optical fiber cable.
4. Maximum Attenuation: 3.50 dB/km at 850 nm wavelength; 1.5 dB/km at 1300 nm wavelength.
5. Jacket Color: Aqua.

D. Types OFN and OFNG, Designation OS2, Inside-Outside Plant, Single-Mode Optical Fiber Cable:

1. Source Limitations: Obtain products from single manufacturer.
2. Additional Characteristics:
 - a. Construction: TIA-492CAAB; 9 μ m core diameter, 125 μ m cladding diameter, with low water peak.
 - b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
3. Options:
 - a. Configuration: 12-fiber, tight buffer, optical fiber cable.
 - b. Maximum Attenuation: 0.5 dB/km at 1310 nm wavelength; 0.5 dB/km at 1550 nm wavelength.
 - c. Jacket Color: Blue.

2.2 OPTICAL FIBER CABLE HARDWARE

A. Performance Criteria:

1. Fiber Optic Connector Intermateability Standard (FOCIS) specifications of TIA-604 series.
2. TIA-568.3.

B. Fiber Adapter Enclosure

1. Manufacturers:
 - a. Hubbell FCR2U9SP
 - b. Or approved equal by: Ortronics, Panduit, Systimax.
2. Enclosure design shall be a modular, rack-mounted, powder coated formed cold rolled steel enclosure with a removable front cover, rear panel, top panel, and slide-out inner tray.
3. Each basic unit delivered shall consist of: (1) enclosure assembly, (2) mounting brackets, (6) cable ties, (5) snap-in cable clips (4) #12-24 mounting screws, (1) adhesive grid label, (4) adhesive cable clips, (2) Velcro cable ties, (3) label holders, and (1) splice tray stud, wing nut, and spacer.
4. Material shall be as follows:
 - a. Enclosure, panels and tray: 16 gauge cold rolled steel (CRS)
 - b. Mounting brackets: 14 gage CRS
 - c. Front cover: Acrylic (Plexiglas)
5. Basic dimensions of the enclosures shall be approximately 17" wide by 12" deep.
6. Enclosures shall be available in heights of 3.5" (2U), 5.25" (3U), and 7" (4U)
7. versions.
8. Finish shall be black durable powder coat on all surfaces.
9. Front door shall be Lexan plastic, hinged at the bottom, with a cap-plugged hole to accept an optional lock. Front door shall also be removable in the fully open position by sliding left off the mounting pins.
10. Front door shall be secured in the closed position with magnetic quick-release latches.
11. Top cover shall be removable in the forward direction, without fasteners, to provide access to the connector field. Top panel shall also have knockouts for backbone cable entry.
12. Rear panel shall be removable without fasteners.
13. Enclosure shall be equipped with panel-mounting brackets assembled for 19" rack mounting, compliant to ANSI/EIA-310-D.
14. Panel mounting brackets shall be configurable to either 19" or 23" racks.
15. Enclosure chassis shall have two mounting bracket locations for either flush mount or center mount on the rack.
16. Rear of enclosure shall have two knockouts, top and bottom, for backbone cable entry and internal routing.
17. Front of enclosure chassis shall have side cutouts for patch cord entry into, and exit from the enclosure.

18. Inner tray shall slide out in the forward direction by releasing the lever-action quick-release latches. Tabs in the chassis shall engage with slots in the inner tray in the outward position to prevent tray from falling out.
19. Inner tray shall have rear-located knockouts to match rear chassis knockouts.
20. Inner tray panel mounting posts shall accept modular adapter panels, in high- or low-density versions. Adapter panels shall be available in singlemode and multimode.
21. Splice tray mounting boss shall also accept a stud for mounting blown fiber adapter brackets.
22. Inner tray shall have clips for cable ties, and holes to accept snap-in cable clips, front and rear, for complete cable management of patch cords and distribution cable strands.
23. Inner tray shall have rear cable tie-down features to accept various diameter backbone cables entering the enclosure.

C. Fiber Adapter Panels Requirements

1. Manufacturers:
 - a. Hubbell FSPLCDM6AQ or FSPLCDS6
 - b. Or approved equal by: Ortronics, Panduit, Systimax.
2. Fiber adapter panels shall be a modular, quick-fastening steel plate, powder coated to match the enclosure finish.
3. Fiber adapter panels shall have pre-installed LC fiber adapters, available in low- or high-density multi-mode or single-mode applications.
4. Each individually bagged unit delivered shall consist of: (1) fully assembled adapter panel, with push-pull fasteners pre-installed.
5. Adapter panels shall be constructed of 16-gauge cold rolled steel.
6. Finish shall be black durable powder coat on all surfaces.
7. Basic dimensions of the FSP panels shall be 5.10" length by 1.10" wide.
8. Panels shall have two pre-installed, push-pull type quick-release fasteners for quick snap-in installation. Push-pull fasteners shall have an industry standard center distance of 4.65".
9. Panels shall be suitable for mounting either vertically or horizontally.
10. Panels shall be available in with LC adapters with precision ceramic alignment sleeves.
11. All fiber adapters installed in FSP panels shall have dust caps installed.
12. Panels shall be available in low-density and high-density adapter patterns.

D. Fiber Connector Requirements

1. Manufacturers:
 - a. Hubbell FCLC900K50GM12 or FCLC900KSM12
 - b. Or approved equal by: Ortronics, Panduit, Systimax.
2. Connector basic design shall be a factory pre-polished LC optical fiber connector with a zirconium ceramic ferrule. Integral with the connector body is a wedge-activated fiber clamping mechanism to secure the inserted fiber into a mechanical splice with the factory installed cleaved fiber stub. Index-matching gel

- is supplied factory-injected into the cleaved fiber stub splice to optimize transmission performance. Connector attachment is achieved without tools, by inserting a field-cleaved optical fiber and then extracting the disposable clamp wedges from the connector body.
3. Each basic connector unit delivered shall consist of: (1) connector body with disposable clamp wedge, (1) strain relief boot, and (1) plastic dust cap.
 4. Connector termination method shall utilize an industry standard multi-layer strip tool and bare fiber cleave tool as the only field tools required.
 5. LC connectors shall have features to enable field verification using a Visual Fault Locator (VFL) during termination.
 6. Connector materials shall be designed with thermal stability to comply with environmental requirements of ANSI/TIA/EIA-568-B.3 and TelCordia GR-1081-CORE.
 7. Singlemode pre-polished fiber connector materials shall be as follows:
 - a. Ferrule: zirconium ceramic
 - b. LC inner body: thermally stable injection molded thermoplastic
 - c. Dust Cap: nylon or PVC
 - d. Strain relief boot: UL94-V0 molded PVC
 - 8.
 9. Pre-polished LC connectors shall require no field polishing.
 10. Pre-polished OM4 LC connectors shall require no adhesives for termination.
 11. LC connector internal fiber clamping mechanism shall firmly secure both the inserted glass fiber and the 900 micron buffer layer of the inserted fiber for maximum strain relief.
 12. All standard mating and interface dimensions for LC connectors shall comply with ANSI/TIA/EIA-604-10 (FOCIS 10).
 13. Ferrule outside diameter for LC singlemode connectors shall be 1.2483mm to 1.2497mm.
 14. LC ferrule tip shall have a PC spherical radius of approximately 7.0 mm radius for singlemode versions.
 15. Delivered connectors shall be individually bagged with the dust cap installed to protect from contamination.
 16. Delivered connectors shall have the disposable clamp activation wedge element pre-installed onto the connector body.
 17. Connector design and termination technique shall be independent of cable type or manufacturer and shall be compatible for either 900 micron buffer or 250 micron buffer distribution cables.
 18. LC connector strain relief boot shall be a TelCordia style slotted design for maximum flexural strain relief.
 19. Pre-polished LC fiber connectors, when properly installed onto qualified cable, shall meet the 10 Gb/s Ethernet performance requirements of IEEE802.3.
 20. Pre-polished LC fiber connectors, properly installed onto qualified cable, shall exceed the mechanical and environmental performance requirements of ANSI/TIA/EIA-568-C.3, Annex 'A'.
 21. Pre-polished LC fiber connectors, properly installed onto qualified cable, shall exceed the mechanical and environmental performance requirements of TelCordia GR-1081-CORE.
 22. Qualification test data shall be available from the manufacturer upon request.

E. Patch Cords: Factory-made, dual-fiber cables in 36-inch lengths.

- F. Connector Type: Type LC complying with TIA-604-3, connectors.
- G. Plugs and Plug Assemblies:
 - 1. Male; color-coded modular telecommunications connector designed for termination of single optical fiber cable.
 - 2. Insertion loss not more than 0.75 dB.
 - 3. Marked to indicate transmission performance.
- H. Jacks and Jack Assemblies:
 - 1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of single optical fiber cable.
 - 2. Insertion loss not more than 0.75 dB.
 - 3. Marked to indicate transmission performance.
 - 4. Designed to snap-in to patch panel or faceplate.

2.3 SOURCE QUALITY CONTROL

- A. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.
- B. Testing Administrator: Engage qualified testing agency to evaluate cables.
- C. Tests and Inspections:
 - 1. Test and inspect multimode optical fiber cables, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with TIA-526-14 and TIA-568.3 before delivering to site. Affix label with name and date of manufacturer's certification of system compliance.
 - 2. Test and inspect pre-terminated optical fiber cable assemblies, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with TIA-526-14 and TIA-568.3 before delivering to site. Affix label with name and date of manufacturer's certification of system compliance.
- D. Nonconforming Work:
 - 1. Cables that do not pass tests and inspections will be considered defective.
- E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate backbone cabling with protectors and demarcation point provided by communications service provider.

3.2 SELECTION OF OPTICAL FIBER TYPE

- A. Installed in Vertical Shaft or Floor-to-Floor Riser:
 - 1. Nonconductive:
 - a. Type OFNR.
- B. Installed in Plenum, Duct, or Other Space Handling Environmental Air:
 - 1. Nonconductive:
 - a. Type OFNP in listed plenum communications raceway.
- C. Installed in Location Other Than Riser or Plenum:
 - 1. Nonconductive: Type OFN in metallic conduit.

3.3 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

- A. Optical fiber backbone cabling system must provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.
- B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters may not be used as part of backbone cabling.
- C. Comply with BICSI N1, NECA NEIS 1, and NECA NEIS 301.
- D. Backbone cabling system must comply with transmission standards in TIA-568.1.
- E. Telecommunications Pathways and Spaces: Comply with TIA-569.
- F. Wiring Methods:
 - 1. Not in Raceway: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
 - 2. In Raceway: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
 - a. Install plenum cable in environmental airspaces, including plenum ceilings.
 - b. Comply with requirements for pathways specified in Section 27 05 28 "Pathways for Communications Systems."
 - 3. In Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

G. Optical Fiber Cabling Installation:

1. Comply with TIA-568.1 and TIA-568.3.
2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
3. Terminate all cables; no cable may contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inch and not more than 6 inch from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps may not be used for heating.
9. In communications equipment room, provide 10 ft long service loop on each end of cable.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

H. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable may not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

I. Group connecting hardware for cables into separate logical fields.

3.4 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569, Annex A, "Firestopping."
- C. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.5 GROUNDING

- A. Install grounding in accordance with BICSI ITSIMM, "Grounding (Earthing), Bonding, and Electrical Protection" Chapter.

- B. Comply with TIA-607 and NECA/BICSI-607.
- C. Locate grounding bus bar to minimize length of bonding conductors. Fasten to wall allowing at least 2 inch clearance behind grounding bus bar. Connect grounding bus bar with minimum 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- D. Bond metallic equipment to grounding bus bar, using not smaller than 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
 - 1. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
- B. Comply with requirements in Section 271523 "Communications Optical Fiber Horizontal Cabling" for cable and asset management software.
- C. Cable Schedule: Install in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish electronic copy of final comprehensive schedules for Project.
- D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
- E. Cable and Wire Identification:
 - 1. Label each cable within 4 inch of each termination and tap, where it is accessible in cabinet or junction or outlet box, and elsewhere as indicated.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
 - 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 ft.
 - 4. Label each unit and field within distribution racks and frames.
 - 5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use different color for jacks and plugs of each service.
- F. Labels must be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606, for the following:

1. Flexible vinyl or polyester that flexes as cables are bent.

3.7 FIELD QUALITY CONTROL

- A. Field tests and inspections must be witnessed by Tenant.

- B. Tests and Inspections:

1. Visually inspect optical fiber jacket materials for qualified electrical testing laboratory certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Optical Fiber Cable Tests:
 - a. Test instruments must meet or exceed applicable requirements in TIA-568.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - b. Link End-to-End Attenuation Tests:
 - 1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in one direction in accordance with TIA-526-14, Method B, One Reference Jumper.
 - 2) Attenuation test results for backbone links must be less than 2.0 dB. Attenuation test results must be less than those calculated in accordance with equation in TIA-568.1.

- C. Nonconforming Work:

1. Cables will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective cables and retest.

- D. Collect, assemble, and submit test and inspection reports.

1. Data for each measurement must be documented.
2. Data for field quality-control report submittals must be printed in summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from instrument to computer, saved as text files, and printed and submitted.

END OF SECTION 27 13 23

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SECTION 27 15 13

COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Category 6A twisted pair cable.
2. Twisted pair cable hardware, including plugs and jacks.
3. Multiuser telecommunications outlet assembly.
4. Cable management system.
5. Cabling identification products.
6. Grounding provisions for twisted pair cable.
7. Source quality control requirements for twisted pair cable.

1.2 DEFINITIONS

- A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- B. EMI: Electromagnetic interference.
- C. FTP: Shielded twisted pair.
- D. F/FTP: Overall foil screened cable with foil screened twisted pair.
- E. F/UTP: Overall foil screened cable with unscreened twisted pair.
- F. IDC: Insulation displacement connector.
- G. LAN: Local area network.
- H. Jack: Also commonly called an "outlet," it is the fixed, female connector.
- I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.
- J. RCDD: Registered Communications Distribution Designer.
- K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

- M. S/FTP: Overall braid screened cable with foil screened twisted pair.
- N. S/UTP: Overall braid screened cable with unscreened twisted pairs.
- O. UTP: Unscreened (unshielded) twisted pair.

1.3 COPPER HORIZONTAL CABLING DESCRIPTION

- A. Horizontal cable cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.
 - 1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
 - 2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
 - 3. Bridged taps and splices shall not be installed in the horizontal cabling.
- B. A work area is approximately 100 sq. ft., and includes the components that extend from the equipment outlets to the station equipment.
- C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Reviewed and stamped by RCDD.
 - 1. System Labeling Schedules:
 - a. Electronic copy of labeling schedules that are part of cabling and asset identification system of software.
 - 2. Cabling administration Drawings and printouts.
 - 3. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:
 - a. Telecommunications rooms plans and elevations.
 - b. Telecommunications pathways.
 - c. Telecommunications system access points.
 - d. Telecommunications grounding system.
 - e. Telecommunications conductor drop locations.

- f. Typical telecommunications details.
- g. Mechanical, electrical, and plumbing systems.

C. Twisted pair cable testing plan.

D. Field Quality-Control Submittals:

- 1. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For RCDD, installation supervisor, and field inspector.

B. Product Certificates: For each type of product.

C. Source quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

- 1. Layout Responsibility: Preparation of Shop Drawings by an RCDD.
- 2. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
- 3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

- 1. Test each pair of twisted pair cable for open and short circuits.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.
- B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.
- C. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
 - 1. Communications, Non-Plenum Rated:
 - a. Type CMR complying with UL 1666.
- B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 450 or less.
- C. RoHS compliant.

2.3 CATEGORY 6A TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6A cable at frequencies up to 500 MHz.
- B. Manufacturers:
 - 1. Hubbell NEXTSPEED Series C6ASPWxx
 - 2. Or approved equal by: Berk-Tek, Systemax, Panduit
- C. Standard: Comply with TIA-568-C.2 for Category 6A cables.
- D. Conductors: 100-ohm, 23 AWG solid copper.
- E. Shielding/Screening: Unshielded twisted pairs (UTP).

- F. Cable Rating: Plenum.
- G. Jacket: Coordinate color selection with owner prior to purchase.

2.4 TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.
- B. General Requirements for Twisted Pair Cable Hardware:
 - 1. Comply with the performance requirements of Category 6A.
 - 2. Cables shall be terminated with connecting hardware of same category or higher.
 - 3. Category 6A panels shall be backward compatible with existing Category 3, 5, and 5e cabling systems for fit, form, and function.
 - 4. Panels shall be UL LISTED 1863 and CSA certified.
 - 5. Panels shall support 4PPOE IEEE 802.3bt Power specification to 1.5 times the rated current limits with no degradation of performance or materials.
 - 6. Panel contacts shall withstand a minimum of 2000 mating cycles with an FCC 8-position RJ-45 plug, without degradation of electrical or mechanical performance.
 - 7. Panels shall be third party verified, error free Gigabit Ethernet performance to IEEE 802.3 standard.
 - 8. Category 6A panels shall meet the current draft 10 Gb/s performance requirements of IEEE 802.3an and TSB-155, for a maximum 55-meter channel length.
- C. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.
 - 1. Manufacturers:
 - a. Hubbell NEXTSPEED HP6A48U
 - b. Or approved equal by Ortronics, Panduit, Systimax
 - 2. Features:
 - a. Universal T568A and T568B wiring labels.
 - b. Unkeyed
 - c. Labeling areas adjacent to conductors.
 - d. Replaceable connectors.
 - e. 48 ports.
 - 3. Construction: 14-gauge steel and mountable on 19-inch equipment racks.
 - 4. Number of Jacks per Field: One for each four-pair cable indicated plus 25% spare capacity.
 - 5. IDC contact termination towers shall have tapered pair-splitting features to aid wire insertion and minimize pair un-twist.
 - 6. IDC contacts shall be Phosphor Bronze with 100 micro-inch tin lead 60/40 plating over nickel.

7. Panel ports shall accept optional hinged dust covers and port identification icon buttons.
- D. Patch Cords: Factory-made, four-pair cables in 36-inch lengths; terminated with an eight-position modular plug at each end.
1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
- E. Plugs and Plug Assemblies:
1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
 2. Standard: Comply with TIA-568-C.2.
 3. Marked to indicate transmission performance.
- F. Jacks and Jack Assemblies:
1. Manufacturers:
 - a. Hubbell model HJS6Axx
 - b. Or approved equal by Ortronics, Panduit, Systimax.
 2. Female; eight position; modular; RJ-45 style, unkeyed, FCC compliant, fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
 3. Designed to snap-in to a patch panel or cover plate.
 4. Standard: Comply with TIA-568-C.2.
 5. Marked to indicate transmission performance.
 6. Modular jack contacts shall accept a minimum of 2000 mating cycles without degradation of electrical or mechanical performance.
 7. Jack contacts shall be constructed of Beryllium copper for maximum spring force and durability.
 8. Category 6A jacks shall be backward compatible with existing Category 3, 5, and 5e cabling systems for fit, form, and function
- G. Cover Plate:
1. Two, Four or Six port, vertical single gang cover plates designed to mount to single gang wall boxes.
 2. Eight, Ten or Twelve port, vertical double gang cover plates designed to mount to double gang wall boxes.
 3. Metal Cover Plate: Stainless steel, complying with requirements in Section 260533 "Raceway and Boxes for Electrical Systems."
 4. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.
 - a. Flush mounting jacks, positioning the cord at a 45-degree angle.

H. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.5 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.6 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test cables on reels according to TIA-568-C.1.
- C. Factory test twisted pair cables according to TIA-568-C.2.
- D. Cable will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

- A. Routing:
1. Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters.
 - a. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."
- B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF PATHWAYS

- A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings."
- B. Comply with Section 270528 "Pathways for Communications Systems."
- C. Comply with Section 270529 "Hangers and Supports for Communications Systems."

- D. Comply with Section 270536 "Cable Trays for Communications Systems."
- E. Drawings indicate general arrangement of pathways and fittings.

3.3 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

- A. Comply with NECA 1 and NECA/BICSI 568.

- B. General Requirements for Cabling:

1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
3. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. MUTOA shall not be used as a cross-connect point.
6. Consolidation points may be used only for making a direct connection to equipment outlets:
 - a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
 - b. Locate consolidation points for twisted-pair cables at least 49 feet from communications equipment room.
7. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
8. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
9. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
10. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
11. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
12. In the communications equipment room, install a 10-foot-long service loop on each end of cable.
13. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.

- C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- D. Group connecting hardware for cables into separate logical fields.
- E. Separation from EMI Sources:
1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
 3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
 4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
 5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 INSTALLATION OF PATCH PANELS

- A. Properly mount patch panels into the designated rack, cabinet, or bracket locations with the #12-24 screws provided.
- B. Terminate cables into the patch panel according to manufacturer's instructions.

- C. To maximize transmission performance, maintain wiring pair twists as close as possible to the point of termination.
- D. The length of wiring pair un-twist in each termination shall be less than 0.5 inches (13 mm).
- E. Horizontal or backbone cables extending from the panel terminations shall maintain a minimum bend radius of at least 4 times the cable diameter.
- F. Cable terminations shall have no tensile or bending strain on panel IDC contacts in each installed location.
- G. Panels shall be properly labeled on front and back with the cable number and port connections for each port

3.5 INSTALLATION OF JACKS

- 1. Terminate jacks according to manufacturer's instructions.
- 2. Jacks shall be properly mounted in plates, frames, or housings with stuffer cap fully installed over IDC contacts.
- 3. Jacks shall be tested as part of the installed horizontal cabling system, with faceplates assembled complete and properly mounted.

3.6 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with "Firestopping Systems" Article in BICSI's "Telecommunications Distribution Methods Manual."

3.7 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."
- C. Comply with TIA-607-B and NECA/BICSI-607.
- D. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.
- E. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.8 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

B. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

C. Nonconforming Work:

1. End-to-end cabling will be considered defective if it does not pass tests and inspections.
2. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

D. Collect, assemble, and submit test and inspection reports.

END OF SECTION 27 15 13

SECTION 28 31 11

DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Fire-alarm control unit.
 - 2. Manual fire-alarm boxes.
 - 3. System smoke detectors.
 - 4. Heat detectors.
 - 5. Notification appliances.
 - 6. Firefighters' two-way telephone communication service.
 - 7. Magnetic door holders.
 - 8. Remote annunciator.
 - 9. Graphic remote annunciator.
 - 10. Addressable interface device.
 - 11. Digital alarm communicator transmitter.
- B. Fire alarm system for the Garage package will be connected to the Courthouse fire alarm system. Both systems must be by the same manufacturer.

1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. NICET: National Institute for Certification in Engineering Technologies.

1.4 SYSTEM DESCRIPTION

- A. Noncoded, UL-certified addressable system, with multiplexed signal transmission, dedicated to fire-alarm service only.
- B. Noncoded addressable system, with automatic sensitivity control of certain smoke detectors and multiplexed signal transmission, dedicated to fire-alarm service only.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
 - 2. Include voltage drop calculations for notification appliance circuits.
 - 3. Include battery-size calculations.
 - 4. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 - 5. Graphic Annunciator panel details as required by authorities having jurisdiction.
 - 6. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
 - 7. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
 - 8. Include floor plans to indicate final device locations showing address of each addressable device. Show size and route of cable and conduits.
 - 9. Provide manufacturer product data for all components of the fire alarm system.
- C. General Submittal Requirements:
 - 1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
 - 2. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design.
 - b. NICET-certified fire-alarm technician, Level IV minimum.
 - c. Licensed fire alarm contractor in the state of Delaware

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
3. Record copy of site-specific software.
4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
 - a. Frequency of testing of installed components.
 - b. Frequency of inspection of installed components.
 - c. Requirements and recommendations related to results of maintenance.
 - d. Manufacturer's user training manuals.
5. Manufacturer's required maintenance related to system warranty requirements.
6. Abbreviated operating instructions for mounting at fire-alarm control unit.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Lamps for Remote Indicating Lamp Units: Quantity equal to percent of amount installed, but no fewer than 1 unit.
 2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
 3. Smoke Detectors, Heat Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than 1 unit of each type.
 4. Detector Bases: Quantity equal to 10 percent of amount of each type installed, but no fewer than 1 unit of each type.
 5. Keys and Tools: One extra set for access to locked and tamperproof components.
 6. Audible and Visual Notification Appliances: 2 of each type installed.
 7. Fuses: Two of each type installed in the system.

1.9 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

- B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level IV technician and licensed fire alarm contractor in the state of Delaware
- C. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

1.10 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
 - 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.11 WARRANTY

- A. Provide 5-year extended manufacturer warranty for control panel components.
- B. The warranty period shall start at the date of overall substantial completion for the project.
- C. Submit a sample warranty for approval before purchasing equipment.
- D. See section 01 77 00 – Closeout Procedures for additional warranty requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Notifier, a Honeywell Company. Subject to compliance with requirements, provide comparable product by one of the following:

1. Fire Control Instruments, Inc.; a Honeywell company.
2. Siemens Building Technologies, Inc.; Fire Safety Division.
3. SimplexGrinnell LP; a Tyco International company.
4. Edwards
5. Gamewell-FCI; Honeywell International, Inc.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices:

1. Manual stations.
2. Heat detectors.
3. Smoke detectors.
4. Duct smoke detectors.
5. Verified automatic alarm operation of smoke detectors.
6. Automatic sprinkler system water flow.
7. Heat detectors in elevator shaft and pit.
8. Fire standpipe system.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.
2. Identify alarm at fire-alarm control unit and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Activate voice/alarm communication system.
7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
8. Activate smoke-control system (smoke management) at firefighter smoke-control system panel.
9. Activate stairwell and elevator-shaft pressurization systems.
10. Close smoke dampers in air ducts of designated air-conditioning duct systems.
11. Recall elevators to primary or alternate recall floors.
12. Activate emergency lighting control.
13. Record events in the system memory.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. Low-air-pressure switch of a dry-pipe sprinkler system.
3. Detection of gas by the Gas Detection System
4. Elevator shunt-trip supervision.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.

2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 3. Loss of primary power at fire-alarm control unit.
 4. Ground or a single break in fire-alarm control unit internal circuits.
 5. Abnormal AC voltage at fire-alarm control unit.
 6. Break in standby battery circuitry.
 7. Failure of battery charging.
 8. Abnormal position of any switch at fire-alarm control unit or annunciator.
 9. Fire-pump power failure, including a dead-phase or phase-reversal condition.
 10. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system.
- E. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators. Record the event on system printer.

2.3 FIRE-ALARM CONTROL UNIT

- A. General Requirements for Fire-Alarm Control Unit:
1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.
 - a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
 - b. Include a real-time clock for time annotation of events on the event recorder and printer.
 2. Addressable initiation devices that communicate device identity and status.
 - a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit.
 - b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
 3. Addressable control circuits for operation of mechanical equipment.
- B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
1. Annunciator and Display: Liquid-crystal type, minimum 2 line(s) of 80 characters, minimum.
 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.
- C. Circuits:

1. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class A.
 2. Pathway survivability: Level 0
 3. Install no more than 50 addressable devices on each signaling line circuit.
 4. Serial Interfaces: Two RS-232 ports for printers.
- D. Elevator/Stairwell Pressurization: Provide an output signal using an addressable relay to start the stairwell pressurization system. Signal shall remain on until alarm conditions are cleared and fire-alarm system is reset. Signal shall not stop in response to alarm acknowledge or signal silence commands.
1. Pressurization starts when any alarm is received at fire-alarm control unit.
 2. Alarm signals from smoke detectors at pressurization air supplies have a higher priority than other alarm signals that start the system.
- E. Smoke-Alarm Verification:
1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
 2. Activate an NRTL-listed and -approved "alarm-verification" sequence at fire-alarm control unit and detector.
 3. Record events by the system printer.
 4. Sound general alarm if the alarm is verified.
 5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.
- F. Notification Appliance Circuit: Operation shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
- G. Elevator Recall:
1. Smoke detectors at the following locations shall initiate automatic elevator recall. Alarm-initiating devices, except those listed, shall not start elevator recall.
 - a. Elevator lobby detectors except the lobby detector on the designated floor.
 - b. Smoke detector in elevator machine room.
 - c. Smoke detectors in elevator hoistway.
 2. Elevator lobby detectors located on the designated recall floors shall be programmed to move the cars to the alternate recall floor.
 3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
 - a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.
- H. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity

settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.

- I. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
- J. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be connected to fire-alarm system.
- K. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided in a separate cabinet located in the fire command center.
 - 1. Indicated number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711 and be listed by an NRTL.
 - a. Allow the application of and evacuation signal to indicated number of zones and, at same time, allow voice paging to the other zones selectively or in any combination.
 - b. Programmable tone and message sequence selection.
 - c. Standard digitally recorded messages for "Evacuation" and "All Clear."
 - d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification appliance circuits of fire-alarm control unit.
 - 2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
 - 3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.
- L. Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as a special module that is part of fire-alarm control unit.
 - 1. Indicated number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711 and be listed by an NRTL.
 - a. Allow the application of and evacuation signal to indicated number of zones and, at same time, allow voice paging to the other zones selectively or in any combination.
 - b. Programmable tone and message sequence selection.
 - c. Standard digitally recorded messages for "Evacuation" and "All Clear."
 - d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification appliance circuits of fire-alarm control unit.
 - 2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.

3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.
- M. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals supervisory and digital alarm communicator transmitters and digital alarm radio transmitters shall be powered by 24-V dc source.
 1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
- N. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
 1. Batteries: Sealed lead calcium.
- O. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.4 MANUAL FIRE-ALARM BOXES

- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
 1. Double-action mechanism requiring two actions to initiate an alarm, breaking-glass or plastic-rod type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
 2. Station Reset: Key- or wrench-operated switch.
 3. Indoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.
 4. Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

2.5 SYSTEM SMOKE DETECTORS

- A. General Requirements for System Smoke Detectors:
 1. Comply with UL 268; operating at 24-V dc, nominal.
 2. Detectors shall be two-wire type.
 3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
 4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.

5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.
7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.

- a. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).

C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
6. Relay Shutdown: Rated to interrupt smoke damper or fan motor-control circuit.
7. Test Station: Remote key test switch station with LED alarm light. Operation of the key switch shall place the detector into alarm condition, as well as changing the state of the relay contacts and actuating any control function associated with duct detector.

2.6 HEAT DETECTORS

- A. General Requirements for Heat Detectors: Comply with UL 521.
- B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
 - 1. Mounting: Adapter plate for outlet box mounting.
 - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.7 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.
 - 1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.
 - 2. Vandal resistant devices: Devices marked as Vandal Resistant in drawings shall be provided with device guard per this specification.
- B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.
- C. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.
 - 1. Rated Light Output:
 - a. 15/30/75/95/110 cd, selectable in the field.
 - 2. Mounting: Wall mounted unless otherwise indicated.
 - 3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
 - 4. Flashing shall be in a temporal pattern, synchronized with other units.
 - 5. Strobe Leads: Factory connected to screw terminals.
 - 6. Mounting Faceplate: Factory finished, red.
- D. Voice/Tone Notification Appliances:
 - 1. Appliances shall comply with UL 1480 and shall be listed and labeled by an NRTL.
 - 2. High-Range Units: Rated 2 to 15 W.
 - 3. Low-Range Units: Rated 1 to 2 W.

4. Mounting: Flush.
5. Matching Transformers: Tap range matched to acoustical environment of speaker location.

2.8 FIREFIGHTERS' TWO-WAY TELEPHONE COMMUNICATION SERVICE

- A. Dedicated, two-way, supervised, telephone voice communication links between fire-alarm control unit, the fire command center, and remote firefighters' telephone stations. Supervised telephone lines shall be connected to talk circuits by controls in a control module. Provide the following:
1. Selective-talk type for use by firefighters and fire wardens.
 2. Controls to disconnect phones from talk circuits if too many phones are in use simultaneously.
 3. Audible Pulse and Tone Generator, and High-Intensity Lamp: When a remote telephone is activated, it causes audible signal to sound and high-intensity lamp to flash.
 4. Selector panel controls shall provide for simultaneous operation of up to six telephones in selected zones. Indicate ground faults and open or shorted telephone lines on the panel front by individual LEDs.
 5. Display: Graphic to indicate location of caller.
 6. Remote Telephone Cabinet: Flush- or surface-mounted cabinet as indicated, factory-standard red finish, with handset.
 - a. Install one-piece handset to cabinet with vandal-resistant armored cord. Silk-screened or engraved label on cabinet door, designating "Fire Emergency Phone."
 - b. With "break-glass" type door access lock.
 7. Remote Telephone Jack Stations: Single-gang, stainless-steel-plate mounted plug, engraved "Fire Emergency Phone."
 8. Handsets: 2 push-to-talk-type sets with noise-canceling microphone stored in a cabinet adjacent to fire-alarm control unit in the fire command center.

2.9 MAGNETIC DOOR HOLDERS

- A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
1. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
 2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
 3. Rating: 24-V ac or dc.
- B. Material and Finish: Match door hardware.

2.10 FIRE-ALARM GRAPHIC ANNUNCIATORS

- A. Contractor shall be responsible for developing and submitting graphic detail for annunciator. Graphic shall be submitted and approved by engineer and Fire Marshal.

B. Performance Criteria:

1. Regulatory Requirements: NFPA 72.

C. General Characteristics:

1. Graphic Annunciator Panel: Mounted in aluminum frame with nonglare, minimum 3/16 inch (4.76 mm) thick, clear acrylic cover over graphic representation of facility. Detector locations must be represented by red LED lamps. Normal system operation must be indicated by lighted, green LED. Trouble and supervisory alarms must be represented by amber LED.
2. Comply with UL 864.
3. Operating voltage must be 24 V(dc) provided by local 24 V power supply provided with annunciator.
4. Include built-in voltage regulation, reverse polarity protection, RS 232/422 serial communications, and lamp test switch.
5. Surface mounted in NEMA 250, Type 1 cabinet, with key lock and no exposed screws or hinges.
6. Graphic representation of facility must be CAD drawing and each detector must be represented by LED in its actual location. CAD drawing must be at 1:100 scale or larger.
7. LED representing detector must flash two times per second while detector is in alarm.

2.11 REMOTE ANNUNCIATOR

- A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.

1. Mounting: Surface cabinet, NEMA 250, Type 1.

- B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.12 ADDRESSABLE INTERFACE DEVICE

- A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.

- B. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall for power shutdown.

2.13 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.
- B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.
- C. Local functions and display at the digital alarm communicator transmitter shall include the following:
 - 1. Verification that both telephone lines are available.
 - 2. Programming device.
 - 3. LED display.
 - 4. Manual test report function and manual transmission clear indication.
 - 5. Communications failure with the central station or fire-alarm control unit.
- D. Digital data transmission shall include the following:
 - 1. Address of the alarm-initiating device.
 - 2. Loss of ac supply or loss of power.
 - 3. Low battery.
 - 4. Abnormal test signal.
 - 5. Communication bus failure.
- E. Secondary Power: Integral rechargeable battery and automatic charger.
- F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.14 DEVICE GUARDS

- A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
 - 1. Factory fabricated and furnished by manufacturer of device.
 - 2. Finish: Paint of color to match the protected device.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72 for installation of fire-alarm equipment.
- B. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.
- C. Smoke- or Heat-Detector Spacing:
 - 1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
 - 2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
 - 3. Smooth ceiling spacing shall not exceed 30 feet.
 - 4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A in NFPA 72.
 - 5. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.
 - 6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.
- D. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.
- E. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.
- F. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.
- G. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.
- H. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
- I. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling.
- J. Device Location-Indicating Lights: Locate in public space near the device they monitor.
- K. Fire-Alarm Control Unit: Surface mounted, with tops of cabinets not more than 72 inches above the finished floor.
- L. Annunciator: Install with top of panel not more than 72 inches above the finished floor.

- M. Antenna for Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that will resist 100-mph wind load with a gust factor of 1.3 without damage.

3.2 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.
 - 1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
 - 1. Alarm-initiating connection to smoke-control system (smoke management) at firefighter smoke-control system panel.
 - 2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
 - 3. Smoke dampers in air ducts of designated air-conditioning duct systems.
 - 4. Alarm-initiating connection to elevator recall system and components.
 - 5. Alarm-initiating connection to activate emergency lighting control.
 - 6. Supervisory connections at valve supervisory switches.
 - 7. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
 - 8. Supervisory connections at elevator shunt trip breaker.
 - 9. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
 - 10. Supervisory connections at fire-pump engine control panel.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.

3.4 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.5 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by authorities having jurisdiction.

- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
 - b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 - 2. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 - 3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
 - 4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
 - 5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
 - 6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
- E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- F. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.
- H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

- I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 28 31 11

SECTION 28 48 00
EMERGENCY RESPONSE SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Emergency call systems.
2. Two-way emergency communications systems for rescue assistance.

B. Related Requirements:

1. Section 28 31 11 "Digital Addressable Fire-Alarm System" for interfacing emergency response systems with fire-alarm systems.

1.2 DEFINITIONS

- A. ERCES: Emergency responder communications enhancement system.
- B. PES: Public emergency service.
- C. RF: Radio frequency.
- D. UHF: Ultra-high frequency.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Coordination Meeting(s): For emergency communications systems. Conduct meeting(s) at Project site before installation.
 1. Attendees: Installers, fabricators, representatives of manufacturers, representatives of authorities having jurisdiction, and administrators for field tests and inspections. Notify Architect and Construction Manager of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Emergency Call Station Systems:
 - a. Remote telephone cabinets.

2. Two-Way Emergency Communications Systems for Rescue Assistance:

- a. Master control station.
- b. Remote communications stations.
- c. Cabling

B. Shop Drawings:

1. Project general notes.

2. Emergency Call Station Systems:

- a. Device layout.
- b. Block diagrams and cable/conduit routing.
- c. Pathway class and survivability identification.
- d. System communications details.
- e. System sequence of operations.
- f. System mounting details.
- g. Secondary power calculations.

3. Two-Way Emergency Communications Systems for Rescue Assistance:

- a. Device layout.
- b. Block diagrams and cable/conduit routing.
- c. Pathway class and survivability identification.
- d. System communications details.
- e. System sequence of operations.
- f. System mounting details.
- g. Secondary power calculations.

C. Certificates:

- 1. Certification from each system vendor that equipment and components are compatible and represent a complete system in accordance with NFPA 72, NFPA 1221, and specified requirements.

D. Field Quality-Control Submittals:

- 1. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation instructions issued to Installer by manufacturer for the following:

- 1. Installation instructions for emergency call station systems.
- 2. Installation instructions for two-way emergency communications systems for rescue assistance.

B. System Record of Inspection and Testing: Record copy of completed system acceptance testing.

- C. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Warranty documentation.

1.7 REGULATORY AGENCY APPROVALS

- A. Submittals for emergency communications systems requiring approval by authorities having jurisdiction must be signed and sealed by qualified electrical professional engineer or qualified fire protection professional engineer responsible for their preparation. Submit for action by Architect prior to submitting for approval by authorities having jurisdiction.

1.8 WARRANTY FOR EMERGENCY RESPONSE SYSTEMS

- A. Special Installer Extended Warranty: Installer warrants that fabricated and installed system performs in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.
 - 1. Extended-Warranty Period: Two years from date of Substantial Completion; full coverage for labor, materials, and equipment.
- B. Special Manufacturer Extended Warranty: Manufacturer warrants that system performs in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.
 - 1. Extended-Warranty Period: Five years from date of Substantial Completion; full coverage for labor, materials, and equipment.

1.9 WARRANTY FOR BATTERIES

- A. Special Manufacturer Extended Warranty for Batteries: Manufacturer warrants that batteries perform in accordance with specified requirements and agrees to provide repair or replacement of batteries that fail to perform as specified within extended-warranty period.
 - 1. Warranted Cycle Life for Valve Regulated (Sealed) Lead Acid Batteries: Equal to or greater than that represented in manufacturer's published table, but not less than the following, based on annual average battery temperature of 77 deg F:
 - a. For discharge rate not faster than eight hours, discharge duration not longer than eight hours, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than six discharge cycles.

- b. For discharge rate not faster than 30 minutes, discharge duration not longer than 30 minutes, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 20 discharge cycles.
- c. For discharge rate not faster than 15 minutes, discharge duration not longer than 45 seconds, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 120 discharge cycles.

PART 2 - PRODUCTS

2.1 EMERGENCY CALL STATION SYSTEMS

A. Performance Criteria:

1. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- b. Unless otherwise indicated in Contract Documents, products must comply with NFPA 1, NFPA 70, NFPA 72, NFPA 101, ICC IBC, ICC IFB, and local regulations enforced by authorities having jurisdiction.

B. Description:

- 1. The unit shall be a vandal-resistant wall mount that is multi-functional and constructed of stainless steel. It shall include a high quality, hands-free communications device illuminated by a powerful combination blue beacon strobe light that serves to easily identify it from a distance.

C. Construction:

- 1. The housing front shall be constructed of 14-gauge stainless steel.
- 2. Tamper resistant construction.
- 3. UV resistant coating.
- 4. Meets NEMA 4 requirements.

D. Mounting:

- 1. The Emergency Call Station is to be mounted on a flat wall surface
- 2. The Emergency Phone button shall be located on the Call Station and is to be located no more than 48" above ground level to ensure conformance with the ADA requirements.

E. Electrical:

- 1. All electrical components shall have a modular plug for easy service and replacement, and equipped with a fuse for protection from transient voltage conditions.
- 2. Conduit knockouts shall be available in the bottom of the unit.

3. The unit shall have the option of connectivity to 120V AC primary power.
4. The unit shall have the option for Power over Ethernet for connectivity to a VoIP network switch with 802.3af or 802.3at (minimum) capabilities.

F. Lighting:

1. LED Beacon/Strobe shall be blue.
2. The 12v strobe light shall be located within the Emergency Call Station. The strobe shall be activated upon pushing of the emergency phone button.

G. Communications:

1. Unit shall have ADA compliant speaker phone communication device
2. EIA/TIA, ANSI, CSA and BICSI cabling or similar standards shall be adhered to for proper operation of devices connected to copper or fiber infrastructure.
3. The phone shall activate with one push of the button. Once the button has been pushed, the phone will call programmed emergency numbers and two-way communication will open up. The phone must be capable of being programmed with up to 5 emergency numbers.
4. Call cannot be disconnect by the caller and must be terminated by the called party.

H. Graphics:

1. Engineering grade reflective vinyl for high visibility and legibility.
2. The standard "EMERGENCY" text shall be printed on the housing

2.2 TWO-WAY EMERGENCY COMMUNICATIONS SYSTEMS FOR RESCUE ASSISTANCE

- A. Description: This category includes equipment for providing two-way emergency voice communication for areas of refuge, stairway landings, elevator landings, and occupant evacuation elevator lobbies in accordance with NFPA 72.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Honeywell or approved equal.
- C. Performance Criteria:
1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - b. Unless otherwise indicated in Contract Documents, products must comply with NFPA 1, NFPA 70, NFPA 72, NFPA 101, ICC IBC, ICC IFB, and local regulations enforced by authorities having jurisdiction.
 2. Listing Criteria: UL 2525 and NFPA 72.

D. General Characteristics:

1. Master Control Station: Shall be provided under Courthouse Package. End devices selected must be compatible with Master Control Station that meets the criteria below.
 - a. Mount in fire command center to provide power, supervision, and control for two-way emergency communications systems for rescue assistance.
 - b. Power Supply: 24 V(dc) supply system including batteries, automatic float-charge battery charger, and automatic transfer switch.
 - c. Communicate between master control station handset, Remote Communications Stations and Remote Outstations.
 - d. Annunciate visual and audible signal at master control station when remote Outstation call button is pushed.
 - e. Silence audible signal when master control station handset is removed and Remote Outstation is acknowledged.
 - f. Display identification for location of remote communications stations in building.
 - g. System shall dial out to 911 after 30 second if master control station handset is not answered.
2. Remote Communications Stations:
 - a. Compatible with Master Control Station
 - b. Minimum 10 lines of communication with Remote Outstation available.
 - c. Battery: 5Ah, 12V Lead acid
3. Remote Outstation:
 - a. Single-gang, stainless steel-plate mounted station with hands-free, two-way communication.
 - b. Unit shall be stainless steel.
 - c. LED status indicator
 - d. Push-button call and cancel option.
 - e. Powered from the Master Control Station or Remote Communication station
4. Pathway Survivability:
 - a. Riser Cables: Level 2 or 3.
 - b. Feeder Cables: Level 0.
5. Cabling shall comply with manufacturers requirements.

PART 3 - EXECUTION

3.1 COMMON INSTALLATION REQUIREMENTS FOR EMERGENCY RESPONSE SYSTEMS

- A. Comply with manufacturer's published instructions.
- B. Reference Standards:
 - 1. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 1, NFPA 70, NFPA 72, NFPA 1221, NFPA 101, ICC IBC, ICC IFB, and local regulations enforced by authorities having jurisdiction for installation of emergency communications systems.
 - 2. Comply with NECA 305 for installation of emergency communications systems devices and their connections to fire-alarm system.
 - 3. Consult Engineer for resolution of conflicting requirements.
- C. Installation for Survivability:
 - 1. Where NFPA 72 or NFPA 1221 Survivability Level 2 or 3 pathways are indicated or required, install cables and pathways within 2-hour fire-resistance-rated enclosures or provide fire-resistive pathway installation in accordance with NFPA 72 or NFPA 1221.
 - 2. Install control equipment, power supplies, junction boxes, terminal cabinets, or similar components within dedicated 2-hour fire-resistance-rated fire-alarm system equipment rooms if components originate from or comprise a portion of NFPA 72 or NFPA 1221 Survivability Level 2 or 3 pathway.

3.2 INSTALLATION OF EMERGENCY CALL PHONE SYSTEMS

- A. Interfaces with Other Work:
 - 1. Coordinate installation of new products for emergency responder telephone systems with other systems.
 - 2. Devices shall be surface mounted.
 - 3. Cabling shall be installed in conduit per Specification 260533 "Raceways and Boxes for Electrical Systems."
 - 4. Remote Outstations call button shall be installed no more than 48" above finished floor.

3.3 INSTALLATION OF TWO-WAY EMERGENCY COMMUNICATIONS SYSTEMS FOR RESCUE ASSISTANCE

- A. Interfaces with Other Work:

1. Coordinate installation of new products for two-way emergency communications systems for rescue assistance with other systems.
2. Coordinate with Section 283111 "Digital Addressable Fire-Alarm Systems" for interfaces with fire-alarm system.
3. Devices shall be surface mounted.
4. Cabling shall be installed in conduit per Specification 260533 "Raceways and Boxes for Electrical Systems."
5. Remote Outstations call button shall be installed no more than 48" above finished floor.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."

3.5 FIELD QUALITY CONTROL OF EMERGENCY CALL STATION SYSTEMS

- A. Acceptance Testing Preparation:
 1. Testing cabling in accordance with Specification 271513 "Communications Copper Horizontal Cabling."
 2. Complete system functionality testing shall be completed after construction of and connection to the Courthouse infrastructure.
- B. Field tests and inspections must be witnessed by Owner.
- C. Tests and Inspections:
 1. Perform manufacturer's recommended tests and inspections.
 2. Perform field tests and inspections required by NFPA 72 and NFPA 1221.
- D. Nonconforming Work:
 1. Device will be considered defective if it does not pass tests and inspections.
 2. Remove and replace defective units and retest.
- E. Collect, assemble, and submit test and inspection reports.

3.6 FIELD QUALITY CONTROL OF TWO-WAY EMERGENCY COMMUNICATIONS SYSTEMS FOR RESCUE ASSISTANCE

- A. Acceptance Testing Preparation:

1. Testing cabling in accordance with Specification 271513 "Communications Copper Horizontal Cabling."
 2. Complete system functionality testing shall be completed after construction of and connection to the Courthouse infrastructure.
- B. Field tests and inspections must be witnessed by Owner.
- C. Tests and Inspections:
1. Perform manufacturer's recommended tests and inspections.
 2. Perform field tests and inspections required by NFPA 72 and NFPA 1221.
- D. Nonconforming Work:
1. Device will be considered defective if it does not pass tests and inspections.
 2. Remove and replace defective units and retest.
- E. Collect, assemble, and submit test and inspection reports.
- 3.7 PROTECTION
- A. After installation, protect emergency communications systems devices from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.
- 3.8 DEMONSTRATION
- A. Engage a factory-authorized service representative to train Owner's personnel on how to operate the following systems in accordance with Section 01 79 00 "Demonstration and Training."
1. Emergency call systems.
 2. Two-way emergency communications systems for rescue assistance.
- B. Provide video recording of training in accordance with Section 01 79 00 "Demonstration and Training."

END OF SECTION 28 48 00

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